The Potato News Bulletin

Published Monthly by

The Potato Association of America

VOL. II. NO. 12 DECEMBER, 1925

Fertilizer Number

THE STATUS OF POTATO FERTILIZATION IN NEW YORK

E. V. Hardenburg, Cornell University, Ithaca, N. Y.

New York ranks first over a period of years as the leading potato state in total production. Much of the available potato soil has been occupied by this crop sufficiently long to necessitate the use of varying amounts of fertilizer for the maintenance of profitable yields. This is particularly true of the Long Island area where the crop is grown in most cases year after year on the same land.

Whereas the upstate growers very generally plant potatoes on sod land which has been top-dressed with stable manure, the Long Island growers have had to meet the problem of maintaining the soil humus supply through the use of winter rye green manure crops in the absence of available manure. Naturally the fertilizer problems and practices of the upstate grower located on heavy soil and practicing rotation are quite different from those of the Long Island grower on relatively light soil under continuous cultivation.

Fifteen years ago more or less stable manure was used in potato production even on Long Island. Much of this was shipped on flat cars from the large Eastern cities. Only occasionally was rye used as a green manure cover crop. 1500 pounds to the acre of commercial fertilizer was considered a liberal application and this was most commonly purchased in the analysis of 2-8-10. At the present time with no manure available and with the problem of maintaining both mineral and humus fertility greatly increased, practices have changed considerably. Today the average acre application of commercial fertilizer is between a ton and a ton and a half. Rye is the principal green manure crop and it is the exception to find a grower not using it between potato crops every year.

Even considerable interest is now manifest in the search for green manures which may prove of more value than rye. The Vegetable Research Farm at Riverhead is conducting a compre-

hensive experiment with various forage grasses and legumes singly and in combinations with the idea of determining their influence on potato yields. Very few of these have shown greater promise than rye, although the combination of winter vetch with rye is becoming more popular every year.

Prior to the world war the 2-8-10 was the most common analysis of commercial fertilizer. Recent experiments, both in New York and in other states, have indicated that even the light and potash deficient soils of Long Island do not require so much potash in applications of a ton or more per acre of this analysis. Hence today we find the very general usage on Long Island of commercial fertilizer analyzing approximately 5-8-7. This practice is apparently justified by the results of fertilizer studies made in cooperation with the U. S. Department of Agriculture at Southold, Long Island, in 1924. The varying amounts of potash in the form of sulphate of potash and the resulting yields per acre from this test are given below:

Analysis	Per cent of Potash	Yield per Acre
4-8-0	None	266
4-8-3	3% Sulphate	283
4-8-5	5% "	287
4-8-7	7% "	272
4-8-9	9% "	273

In the above figures it is apparent that not over 5 per cent of actual potash is justified. As the amount of fertilizer used increases each year in this region, the factor of the method of application becomes increasingly important. Originally most of it was applied in the drill row with the planter at time of planting. Recent experiences have been reported in which some injury to the plants from burning has occured. Some of the growers are now practicing two applications: one, by broadcasting just before planting; the other, through the planter in the drill row. The improved planters—some of them two-row planters—are now provided with special fertilizer distributors which insure the spreading of the fertilizer at either side of the seed piece and thereby better insure against burning.

The growers in upstate New York on the heavier soils have been much slower to adopt approved fertilizer practices. Here, as on Long Island, the principal pre-war practice was to use the 2-8-10 fertilizer for this crop. At that time the usual application averaged about 500 pounds to the acre, whereas today the acre application has increased to nearer 700 to 800 pounds. The majority of growers are still adhering to the old 2-8-10 analysis.

Both demonstrations and carefully controlled experiments have shown that little or no commercial potash is needed under these conditions. The plentiful supply of natural potash present in the

heavy soils supplemented by liberal applications of stable manure insure sufficient potash for potatoes on most upstate New York farms. Whereas the limiting element is unquestionably phosphorus, the growers are being constantly urged to use acid phosphate in rather liberal quantity. To date it has been extremely difficult to get growers to change fertilizer practice as above recommended. One reason for this is doubtless the factor of cheapness of the 2-8-10 from the standpoint of total plant food units supplied.

Where stable manure is not available, growers are urged to use a 4-12-4 mixed fertilizer, this being one of New York's "High Five."

An important factor in the efficiency of potato fertilizer practice is depth of application. Many growers broadcast their fertilizer on the surface, depending upon a light harrowing to mix it with the soil. This practice is partly borne of fear of leaching. Yet it has been shown by the lysimeter experiments both at Cornell and elsewhere that the leaching factor, except for nitrate nitrogen, is relatively negligible. There is a rather common notion that plant roots will forage for fertilizer. On the contrary, as between the two factors, distribution of fertilizer and depth of water table, the latter is much more influential in determining the root development. Hence, placing the fertilizer not shallower than the water table will insure its becoming available to the plant regardless of seasonal conditions. This, therefore, seems a sufficient basis for recommending that fertilizer never be placed shallower than the seed piece.

PLACE OF FERTILIZERS IN POTATO PRODUCTION

Daniel Dean, Nichols, New York

The sale of commercial fertilizers for use on potatoes has grown from very small proportions thirty years ago to an immense trade. From the position of being regarded by farmers as a quack medicine, or as a last desperate resort when a soil had become too exhausted to produce by other means, fertilizers have come to take the position of a recognized integral part of potato producton by many thousands of farmers. These men look upon their investment in fertilizers each season as a conservative business investment, practically certain to give good returns.

Study of records of potato production dating back nearly to the Civil War shows a steady fall in annual acre yields during most of the period of falling prices to farmers. From the five year average of 94.5 bushels per acre for the period 1868-72 yields fell to only 74 bushels for the period 1888-92, with several seasons under 60 bushels. Between 1874 and 1904 only one season had a yield exceeding 100 bushels, that of 1895 with 102.3, a year when potatoes sold for the lowest prices of the period.

Seasonal fluctuations were very violent. The high yield of 1895 had been preceded by one of only 63.2 bushels in 1894, showing a gain of over sixty per cent from one year to another.

Since then there has been a steady increase in the average acre yield, and the fluctuations from year to year have been less violent. The high records are those of 1924 for a single season, with 124.2 bushels and 108 for the five year period of 1920-24.

As potatoes have become more profitable, their production has been more and more concentrated in the hands of specialized potato growers, largely concentrated in areas like Aroostook specializing in potato production. It is this type of man that is responsible for the immense increase in the use of fertilizers. From the use of a few hundred pounds per acre by occasional individuals in the last century, the potato growers over large areas often use a ton per acre of high grade goods to produce tens of millions of bushels of potatoes. It is certain that a large part of the gain in average yield of potatoes must be credited to the heavy use of fertilizers, along with due credit to the use of the best tillage and spraying machinery and the improvements in seed constantly going on.

Study of statistics of potato yields shows that fertilizers not only greatly increase yields in the sections most using them, but they also have the great advantage of reducing fluctuations in yield. From the standpoint of national efficiency, and that of cash returns to the grower, it is far more important to get a fairly good yield in a year of severe shortage and high prices like the present, than to have a cheaper production in the favorable years without fertilizers being used. As an example of consistent yields, the writer in a region where rainfall is not heavy has used fertilizers for twenty consecutive years, and in that time has had but two crops, those of 1911 and 1919 when the main crop varieties fell under 200 bushels per acre.

What is the future of commercial fertilizers for use on potatoes? In the past the writer has talked in the middle west where there existed the same strong prejudice against fertilizers which was felt in the east thirty and forty years ago. At present their use is heaviest in the states along the Atlantic coast, most of all in the most highly specialized potato growing sections. At present there are large areas in the middle west where in most recent seasons potatoes have brought low prices because of freight costs to the seaboard cities. At the same time, fertilizer freights have been heavier than to the sections now using fertilizers most. If, as the writer believes, the economic positions of farmers is to improve for a long time to come, the use of fertilizers on potatoes will become profitable over large areas where sales are now small. It is probable that certified seed growers will find the use of fertilizers profitable long before growers of table stock. The producer of certified seed needs a consistently good yield from year to year to keep his reputation and his market. With carefully used fertilizers he can largely prevent much of the second growth and hollow heart, as well as too small size which spoils the appearance of po-

tatoes for seed sale. It is well worth investigating whether seed potatoes which have grown through their life in the field without serious check are not worth more than those which suffered from heat and drouth.

It is obvious that when the use of fertilizers on potatoes is extended to new areas, much experimentng will be necessary to find the best analysis, the best raw materials, and the best quantity to use. It is safe to predict that the great expansion in the use of fertilizers on potatoes in the last thirty years will be followed by another equally great in the next.

QUALITY IN FERTILIZERS

H. R. Talmage, Riverhead, Long Island, N. Y.

Charlie Maxwell is a potato grower. He uses about 60 tons of a fertilizer analyzing 5-8-4 each year. He and a few of his neighbors pool their orders, amounting to 300 tons a year, and get the different companies selling in their neighborhood to "Bid" on the order, promising the order to the lowest bidder. There are no adequate specifications of the materials that enter into the goods to protect the buyers.

By this method they usually are able to get a price from 2 to 3 dollars a ton lower than the regular price at which a fertilizer of that analysis is being sold. About half of this saving is due to a "quantity discount." How can the balance of the reduction in price be made by the fertilizer manufacturer and still make a legitimate profit? I think no one who knows the financial status of the fertilizer industry will claim the manufacturer has been making more than a legitimate profit during the past few years.

The above instance is only one of a multitude of groups of farmers, small cooperatives and larger cooperatives, who buy in this way. It is also true that a very large proportion of the individual growers let price, and price alone, determine where they buy their commercial fertilizers when there is any difference in price.

Charlie Maxwell and his group will pay more than $10,000 for their order of fertilizer this season. Would they spend that amount of money for anything else and totally ignore quality in their purchase? Of course not. If they were to go to a store to purchase a beef steak, a pair of shoes, or a suit of clothes, they surely would take into consideration quality as well as price.

It is very seldom that the old established fertilizer companies, who have a good reputation, will cut prices in order to get this kind of pooled business, for two reasons. **First,** they will not lower the quality of their goods, thereby injuring their reputation; **Second,** if they should work for nothing one season on such an order for the sake of future business it might bring, there is no incentive,

as this kind of business will go the next season, to the company naming the lower price.

It is a fact that there are large fertilizer manufacturing companies who cater to this pooled order and cooperative fertilizer business. They have no established trade in branded goods. They have no reputation to lose, and by using a cheaper grade of materials, can still make a handsome profit by sacrificing quality.

The "Guaranteed Analysis" does not protect the buyer any more than a suit guaranteed to be all wool will protect the buyer against shoddy, or the buyer of a pair of shoes guaranteed to be all leather, from the use of cheap leather.

The Ammonia in a 5-8-4 fertilizer costs nearly twice as much as the Available Phos. acid and the Potash combined. It is in the ammonia content where the fellows who buy on price alone get stuck. And it is in the organic ammoniates where the danger lies. All kinds of materials, from Pearl button dust, leather, hair, and garbage tankage to sulphate of ammonia and nitrate of soda are used. Some are worthless for fertilizer purposes, and some are the best obtainable. The analyses on the package does not protect the buyer from the use of the worthless, cheap materials. Just so sure as fertilizer buyers buy on price alone and force the manufacturer to cheapen his goods in order to get their trade, will they get inferior goods.

The older people know, and I can assure the younger ones that there is very little satisfaction through life in buying inferior goods because they are cheap. With many articles the chief regret from using an inferior article will be one of dissatisfaction. Inferior fertilizers are far more serious. I know of one of my neighbors who had a loss of fifty bushels of potatoes to the acre this season from using a "cheap" fertilizer. At the present price of potatoes that means more than one hundred dollars.

The old saying "Quality Will be Remembered Long After the Price is Forgotten" is just as true of fertilizer as it is of tooth brushes or horses.

We potato growers should remember that it is as important to consider quality before price in buying our fertilizer as it is in buying seed, particularly when we have to use large quantities of fertilizer.

THE INFLUENCE OF SOIL TYPE ON SEED POTATOES

E. V. Hardenburg, Department of Vegetable Gardening
Cornell University

The potato growers of Long Island are annually faced with the problem of buying seed potatoes which will give profitable yields at reasonable cost. Whereas most of this seed used to originate in Maine, it is now obtained in large quantity also from Prince Edward Island, New York, Vermont, New Brunswick, Wisconsin,

and Minnesota. Very few growers depend upon one source for their entire seed supply. Seed buying has become a matter of "not putting all of one's eggs in one basket."

Such a diversity of seed sources naturally results in the use of seed grown on a diversity of soil types varying from heavy silt or clay to light sandy loam or even muck. It is true that most of the seed stock from these sources is grown on fairly light soils, however, there remains the question whether seed potatoes grown on heavy soil types are as productive. A considerable area of heavy soil is devoted to seed production in Maine, Western New York, and Pennsylvania. Large areas of peat and muck soils are now being used and developed for this purpose in Michigan and Minnesota. In New York State, seed potatoes of the Cobbler type are produced on muck at Elba in Genesee County and of the Green Mountain and Pearl type at Hudson Falls in Washington County. In the past, there has been some prejudice against muck-grown seed as well as against muck-grown table potatoes.

The Department of Vegetable Gardening began in 1923 a series of field experiments designed to study the influence of soil type on seed potatoes. Such factors as tuber-set, tuber shape, eating quality, weight of top, and yield have been studied. In 1923 a strain of Irish Cobblers was grown on both muck and sandy loam soil at Kirkville, N. Y. Similarly a strain of Green Mountains was grown on muck and stony loam soil at Marion, N. Y. and a strain of Rural New Yorker No. 2 on light sandy loam and heavy silt loam at Ithaca. In case of each variety, the average number of tubers per hill was highest in the lighter and better aerated soils including the muck plots. Also the tubers from the lighter soils were flatter in shape than those grown on the heavier soil types. In 1924 a sample of seed of each variety and from each soil type was tested for yield both at Ithaca and at Riverhead. The results of these tests are given below in tabe I:

TABLE I. 1924 Test of Seed Potatoes Grown on Different Soil Types in 1923

		Test at Ithaca		Test at Riverhead	
Soil Type Used 1923	Variety	U.S. No.1 bushels per acre	Total yield bu. per acre	U.S. No.1 bushels per acre	Total yield bu. per acre
Muck	Cobbler	324.8	376.0	96.9	141.6
Sandy loam	Cobbler	312.7	345.0	82.7	121.4
Sandy loam	Rural	401.0	421.9	34.3	76.7
Heavy Silt loam	Rural	401.0	422.7	27.6	58.1
Muck	Green Mt.	446.9	474.0		120.5
Stony Silt loam	Green Mt.	428.0	456.2		113.2

It is interesting to note that the muck-grown seed outyielded the upland-grown seed by a significant margin in all cases in the

1924 tests. Altho the sandy loam-grown seed outyielded the seed from havy silt loam in the test at Riverhead, no difference was apparent in the Ithaca test.

The experiment was repeated in 1924, the Green Mountain seed being produced again on the same muck and upland soil plots at Marion, and the Rural seed on the same light and heavy soil plots at Ithaca. As in 1923, the tuber-set was highest in the muck and the sandy loam plots respectively. These four lots of seed were again tested both at Ithaca and Riverhead in 1925. The yield results are shown in table II.

TABLE II. 1925 Test of Seed Potatoes Grown on Different Soil Types in 1924

Soil Type Used 1923	Variety	Test at Ithaca U.S. No.1 bushels per acre	Test at Ithaca Total yield bu. per acre	Test at Riverhead U.S. No.1 bushels per acre	Test at Riverhead Total yield bu. per acre
Sandy loam	Rural	221.1	254.9	95.1	110.8
Heavy Silt loam	Rural	211.8	250.0	59.7	72.2
Muck	Green Mt.	260.2	323.5	131.7	151.4
Stony Silt loam,	Green Mt.	280.3	334.2	131.6	151.0

In both tests, the Rural seed from sandy loam soil outyielded that from the heavy silt. Somewhat in contrast to the 1924 results with the Green Mountains, the test at Ithaca showed in favor of the upland-grown seed, while in the Riverhead test there was no significant difference.

Conclusions

This study is being continued over a period of years. Green Mountain seed has been produced on muck and sandy soil at Elba, N. Y. and Rural seed on the same soil plots at Ithaca in 1925. This seed stock will be tested for yield at both Ithaca and Riverhead in 1926. For three years, tests for cooking quality have been conducted in cooperation with the College of Home Economics. Without exception, the muck and upland-grown potatoes have shown whiter flesh, greater mealiness and better flavor than those from the heavier soils. Regarding comparative value of seed produced on the different soil types, definite conclusions cannot be drawn. There is certainly some indication that the lighter, better aerated soils used in these studies are better adapted to seed production than the heavier soils. The prejudice against muck-grown seed potatoes is apparently not warranted. The results reported here are in no way influenced by the factor of disease, because in all cases high-yielding, disease-free certified seed of known origin has been used.

THE POTATO NEWS BULLETIN

PUBLISHED BY

THE POTATO ASSOCIATION OF AMERICA

AT WASHINGTON, D. C.

"Entered as second-class matter May 31, 1924, at the post office at Washington, D. C., under the Act of March 3, 1879."

SUBSCRIPTION PRICE $1.00 PER YEAR

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THE DECEMBER NUMBER

The final number of The Potato News Bulletin for 1925 is primarily a fertilizer one. It is felt that the articles presented herein will be of interest to the members of the Potato Association of America, especially as they are representative of different sections.

In making preparation for this number, Bailey E. Brown, Biochemist of the Office of Soil Fertility Investigations, U. S. Dept. of Agriculture was consulted several times and the editor wishes to acknowledge his appreciation of Mr. Brown's help in connection with this number as well as the others who have aided so materially.

It was first decided to communicate with members located in different sections of the country requesting that they contribute something of interest from their point of view. If a sufficeint response were obtained it was thought a number of general interest would be possible. The response was very gratifying as evidenced by the articles themselves.

During the year it has been impossible for us under prevailing circumstances to thank the members whenever they rendered assistance which has made the year of 1925 the most successful and prosperous one in the history of our organization.

We take great pleasure in sending forth the December number to the members bearing our **Best Wishes for a Merry Christmas and a Happy New Year.** We also hope that next year will be a good one for every potato grower and that our Association will continue to prosper as it has during the last two years.

GROWTH IN MEMBERSHIP

The Potato Association of America was organized in New York City on November 21, 1912. The first annual meeting was held on February 10-11 at Cornell University, Ithaca, N. Y. The growth of membership taken from the reports of the annual meet-

ings is given below. (Unfortunately several of the reports of the annual meetings have not been published.)

Reports of the annual meetings	Membership
First (Feb. 1914)	66
Third (Nov. 1916)	91
Fourth (Nov. 1917)	129
Eighth (Dec. 1921)	129
Ninth (Dec. 1922)	149
Tenth (Dec. 1923)	270
11th (Dec. 1924)	414*
December 17, 1925 mailing list	1033

* A list of members was not published in the 11th Annual Report but according to the treasurer's report dues to the amount of $828 had been received.

A small number of the 1033 included in the December mailing list have not paid their dues yet for the year. The response to the recent notice the editor sent out to the delinquent members was very gratifying and it is hoped that every member will pay up their dues in a few days.

Dr. E. V. Hardenburg of New York and Prof. Worth G. Covey of North Dakota have greatly helped to swell the membership list recently. During the latter part of the first week in December, Dr. Hardenburg sent out 100 letters to prospective members and to date (Dec. 16) the editor has credited Dr. Hardenburg with the lucky number of 13 new members as a result of his efforts. Prof. Covey has brought up the membership for the state of North Dakota to fifty members.

To quote Dr. Hardenburg, "The growth in membership this year may be contributed largely to the excellent numbers of The Potato News Bulletin."

BASIS FOR INCREASING THE MEMBERSHIP

The question of increasing the membership is one that should be given serious thought. This number demonstrates what can be accomplished by increasing the membership. As the membership increases the advertising rates can be increased proportionally and easier it will be to sell advertising space. Under the present conditions The Potato News Bulletin receives more than one-half of its revenue from advertisements. Therefore we are much indebted to our advertisers.

The question of whether the leading members should pledge money or new memberships is one to be carefully considered. If money is pledged chances are that it may be necessary to pledge it each succeeding year. Furthermore the circulation would not be increased as if the same amount had been received from mem-

bership dues. What has been done in one state or province can be duplicated in another under the proper leadership?

The following table gives the status of the membership and by taking the average production for 1922, 1923, and 1924 for each state and dividing it by 150,000 bushels the following comparisons have been made.

State	Dec. mailing list	Proposed mem'ship on basis of 150,000 bus.	State	Dec. mailing list	Proposed mem'ship on basis of 150,000 bus.
Ala.		2	Nebr.	78	58
Ariz.		22	Nev.		6
Ark.		16	N. H.	2	14
Calif.	23	56	N. J.	27	80
Colo.	15	96	N. M.		2
Conn.	10	22	N. Y.	135	275
Del.	1	6	N. C.	2	34
Dist. Col.	22		N. D.	50	81
Fla.	9	16	Ohio	11	8
Ga.	1	10	Okla.		20
Idaho	14	84	Ore.	8	30
Ill.	16	62	Pa.	19	183
Ind.	3	46	R. I.	2	2
Iowa	1	59	S. C.	1	22
Kan.	11	32	S. D.	15	50
Ky.	13	34	Tenn.		20
La.	8	12	Texas	1	14
Me.	21	218	Utah	4	20
Md.	3	29	Vt.	26	26
Mass.	4	26	Va.	3	104
Mich.	235	248	Wash.	6	54
Minn.	49	286	W. Va.	1	35
Miss.		9	Wis.	14	218
Mo.	5	56	Wy.	2	12
Mont.	43	28			
				Total	2,843

You will observe by looking over the above data that Rhode Island and Vermont are on par with the basis given above and Montana and Nebraska have gone far over the top.

The membership is constantly on the increase and nothing should be allowed to stop its momentum.

OUR PRINTER

As the year closes it is fitting that we should express our appreciation for the unusual consideration and care that has been ren-

dered by Frank E. Skinner, Proprietor of the Pioneer Press and his associates in printing The Potato News Bulletin. No one except the members of the Pioneer Press and the editor knows the difficulties under which some of the numbers have been published. When material came in late that had a timely value and its worth would have greatly depreciated if it had been kept over for the following number; this material was accepted with cheerfulness because the printer realized that by doing it he was helping our publication to get a firm footing. Only those who have had experience know what it costs to shift type in order to place notes or articles in the proper position. This shifting at the last minute has been the cause of the transposition of lines. The editor is glad to relate that material recently has been arriving on time.

The big factor for our gratefulness to the Pioneer Press is the reasonable price that has been charged for printing The Potato News Bulletin. This has been with the idea of helping to foster our new undertaking and looking forward for our business when The Potato News Bulletin becomes more firmly established. The Potato Association of America should feel obligated to continue to give the Pioneer Press its printing.

COMPARISON OF POTATO YIELDS SECURED ON DIFFERENT SOIL TYPES WITH AND WITHOUT FERTILIZER

B. E. Brown, Biochemist
Bureau of Plant Industry, U. S. Dept. Agr.

A well-planned fertilizer experiment as it appears during the height of the growing season is, in the writer's experience, somewhat of an attractive proposition. You have laid out for inspection the effect of various fertilizer combinations, in which the plant food constituents will be no doubt in varying proportions; of nitrogen materials; of potash materials; of phosphoric acid materials; and of many other possible comparisons both as to kind and quantity of fertilizer, on crop growth. In the earliest stages of growth the effect of the various treatments on germination, "come-up", whether accelerated or retarded, and the final stand, may be observed. Finally, the yields, whether of potatoes, corn, wheat, cotton, or whatever the crop may be, are obtained as a closing part of the field work.

In practically all fertilizer experimental work in the field one of the usual things to do is to leave some of the land unfertilized,

probably several sections, in order to determine the immediate effectiveness of the various fertilizers applied.

As potato growers in the specialized regions are accustomed to using rather large applications of fertilizer the writer felt that it would be of some interest to set down the showing made by fertilizer as compared with no fertilizer in the production of this crop.

In order to show this comparison in a brief way, results for the years 1923, 1924 and 1925 obtained cooperatively in Maine, New York, Pennsylvania, New Jersey, and Virginia (2 locations or soil types) have been taken. In all places a 4-10-6 fertilizer was used and the yields secured with such a mixture will be compared with those from the unfertilized.

While it would be of interest to go into some detail with reference to cultural practices followed in the different sections and with respect to seasonal conditions it will not be feasible to do so in this paper. Briefly, however, the Aroostook County, Maine, potato grower generally practices a 3 or 4 year rotation; although to a limited extent some follow potatoes with potatoes. The usual rotation, as is well known, is potatoes, oats, clover and timothy. Any available manure goes on the sod which is turned under in the fall for the following year's potato crop. About one ton of fertilizer is applied to the potato crop at planting time.

In New York, on Long Island, a winter cover-crop system, usually of rye, is followed. The rye is turned under in the spring and the only additional treatment is the fertilizer, usually around 1800-2000 pounds per acre at planting time.

In Pennsylvania, Lehigh County, a rotation is followed of wheat, clover, and potatoes. Manure is used in the rotation and from 800-1200 pounds of commercial fertilizer per acre applied at time of, or just before planting. Quite a number there broadcast the fertilizer ahead of planting and harrow it lightly into the soil.

In New Jersey, Monmouth County, the general plan followed is about as the Long Island grower practices, the chief dependance being a winter cover-crop, usually rye, and the use of about 2000 pounds of fertilizer per acre.

In Virginia, Northampton County, less attention is paid as a rule to adding organic matter, other than volunteer growth. While some turn under rye or crimson clover, alfalfa, etc., generally no consistent practice along such a line is followed. In the spring, at planting time, an application of 1800 to 2000 pounds of fertilizer is made in the furrow before planting. This is "hooked" into the soil with a cultivator. Planting follows as a separate operation.

Hence, there are presented a considerable diversity of soil and climatic conditions and the results presented herein were secured under such a range.

The results for the different locations are given in the table which follows.

TABLE I

Potato Yield Obtained On Different Soil Types With and Without Fertilizer Treatment. Fertilizer Formula Used At All Locations, 4-10-6

Season of	Maine (Caribou loam)			New York (Sassafras loam)			Pennsylvania (Berks sh'le loam)			New Jersey (Sassafras loam)			Virginia (Braden fine sandy loam)			Virginia (Sassafras sandy loam)		
	Fertilized	Unfertilized	Increase	Fertilized	Unfertilized	Increase	Fertilized	Unfertilized	Increase	Fertilized	Unfertilized	Increase	Fertilized	Unfertilized	Increase	Fertilized	Unfertilized	Increase
	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
1923	318.5	210.9	107.6	260.6	118.6	142.0	343.0	213.5	129.5	78.0	56.8	21.2	65.0	32.4	32.6	89.9	63.2	26.7
1924	347.0	237.5	109.5	316.0	221.3	94.7	368.0	292.0	76.0	208.0	72.9	135.1	128.0	37.2	90.8	183.0	149.0	34.0
1925	322.0	211.3	110.7	240.0	183.3	56.7	353.0	266.0	87.0	88.5	72.2	16.3	212.0	122.8	89.2	215.4	125.0	90.4
Average	329.1	219.9	109.2	272.2	174.4	97.8	354.6	257.1	97.5	124.8	67.3	57.5	135.0	64.1	70.9	162.7	112.4	50.3

An examination of the results affords a good idea of what the comparisons amount to, so that no special attempt to discuss the table seems necessary. It should be considered that the results are for three consecutive seasons, some of which, notably that of 1923 in New York, New Jersey and Virginia as well as 1925 in New Jersey, were extremely adverse to the growing crop, consequently the yields were abnormally reduced. Such points, however, give further evidence of the effect of fertilizer under such adverse seasonal conditions which are found to occur, if not in one section, in another. The season of 1924, judging by the reports current relative to the condition of the potato crop and the yields secured, was extremely good.

By the average results for the three seasons it will be noted that the increases due to the fertilizer were as follows: In Maine, on Caribou loam, 109.2 bushels; in New York, on Sassafras loam, 97.8 bushels; in Pennsylvania, on Berks shale loam, 97.5 bushels; in New Jersey, on Sassafras loam, 57.5 bushels; in Virginia, on Braden fine sandy loam, 70.9 bushels; and on Sassafras sandy loam, again in Virginia, 50.3 bushels.

While the increases vary considerably from one section to another it is quite evident that the fertilizer has exerted a prominent influence in bringing about increased yields.

POTASH FOR TRUCK CROP POTATOES IN EASTERN VIRGINIA

H. H. Zimmerly, Horticulturist, Virginia Truck Exp. Station Norfolk, Virginia.

Muriate of potash and sulphate of potash are the two most widely used carriers of potassium in commercial brands of potato fertilizers. Low grade potash containing a large per cent of common salt (sodium chloride) has not been considered a safe source because of the effect of the salt in retarding germination of the potatoes. Haskell of Massachusetts and Patterson of Maryland reported high grade sulphate preferable to muriate for potato production when applied at the time of planting. In Maryland muriate proved superior to sulphate of potash when both were applied three to six months before planting.

At the Virginia Truck Experiment Station an extensive fertilizer experiment was conducted from 1909 to 1922. One part of this was devoted to a comparison of the relative value of muriate of potash and sulphate of potash as the sources of potassium in complete fertilizers for use in the production of some of the more important truck crops. Early potatoes were grown on these plats in 1916, 1918, and 1920. Plats B-75 and 76 each received annually an application of 80 pounds of nitrogen 120 pounds of phosphoric

acid and 160 pounds of potash per acre. On B-75 the potash was supplied as muriate and on B-76 as sulphate.

The yields given in the following tables are totals for sections 5 to 8 of these plats. In addition to the commercial fertilizer used, sections 7 and 8 were treated with stable manure at the rate of 10 tons per acre and on sections 5 and 6 crimson clover was plowed under as a soil improvement crop.

YIELDS OF POTATOES

		— Bushels per Acre —			
Plat	Source of Potash	1916	1918	1920	Average
B-75	Muriate	350	230.7	137	239.2
B-76	Sulphate	331.8	205.3	122.3	219.8

It will be noted that the muriate gave consistently higher yields than the sulphate during each of the three years, with an average increase of 19.5 bushels per acre. Although the amount of potash used on these plats (160 pounds per acre) is somewhat greater than is now being recommended for optimum early yields, no injurous effects from too high concentration was evident on either plat.

On another set of plats, B-73 and B-74, Sections 5 to 8, where 320 pounds of potash, 16 pounds of nitrogen, and 120 pounds of phosphoric acid were used per acre injurious effects of too great amounts of muriate of potash were noted in 1920. This resulted in a marked reduction in yield that year.

		— Bushels per Acre —			
Plat	Source of Potash	1916	1918	1920	Average
B-73	Muriate	351.2	227.7	99.8	226.2
B-74	Sulphate	355.2	237	148.0	246.7

In 1916 and 1918 the sulphate plats gave only slightly higher yields than those secured where muriate of potash was used, while in 1920 the increase was almost 50 per cent. Considerable browning of margins of the leaves and stunting occurred in 1920 on plat B-73 where the excessive amounts of muriate were used. None was evident where the sulphate of potash was used or where the muriate was applied in amounts conducive to optimum yields.

The results of these tests indicate that from the standpoint of yield the muriate is at least equal if not slightly preferable to the sulphate form in Eastern Virginia if proper amounts are used.

Other experiments conducted at this Station have shown that the use of too large amounts of potash retard maturity of the early crop and thus frequently result in financial loss to the grower. In Virginia Truck Experiment Station Bulletin 21, the following summary is given regarding the results secured with different

per cents of potash in a complete fertilizer mixture applied at the rate of 1600 pounds per acre:

"These results indicate that when used in combination with 7 per cent ammonia and 6 per cent phosphoric acid, under the conditions generally existing in the trucking regions of eastern Virginia, that 5 per cent potash may be expected to give better results than either 7 per cent or 3 per cent, and that extra heavy applications of potassium are not advisable. It is realized that the fertilizer mixtures used in these experiments contain ingredients which have a tendency to liberate some of the potash contained in the soil compounds, and that the plants may have obtained a small part of their supply from this source, but the same active ingredients are present in limited quantities in all the commercial fertilizers used in the trucking region, hence the condition under which these experiments were conducted were not abnormal in regard to the available supply of either potassium, phosphorus or nitrogen contained in the soil."

These results have been substantiated also in a later experiment extending over a six-year period, the results of which have not yet been published.

FERTILIZING POTATOES IN MARYLAND

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The diverse character of the soils and climate of Maryland are such as to make it important that consideration be given to the kind of materials to be used in making a formula for the mixing of so-called artificial or chemical manures. When plenty of rotted stable, or barnyard manure, is available and has been used on the land for generations good potatoes may be grown without any other fertilization. Generally, however, it will be found desirable, especially when the crop is planted for early market, to use some "phosphate."

The climate of Maryland is such that potatoes may be, and in fact are, planted from the last week in February until the first week of August. On the lower Eastern Shore the crop for the early market is planted in late February and early March. And the late crop, also the seed crop for early planting, from mid-June to first week of August. The frostless season in this section averages from April 12 until Oct. 30. In the mountain section of the far western part of the state, where the frostless season is from May 12 to Sept. 29, the potatoes are planted in May and June, the main crop in May and some of the early varieties for seed purposes in June. In the central portions of the state two crops are planted, one about the first of April and the other about the first of July.

The soils in these different localities vary widely, that of the Eastern Shore being very light and sandy, while that of the Western

Shore and mountain section contains more loam and clay. On some of the poorer sandy lands potash in liberal amounts is helpful and necessary but on the stiffer soils moderate applications only are needed. Also, nitrogen that is readily available must be supplied to the early crop in generous amounts, but such form of nitrogen is not desirable for the late or midsummer planted crop. The early crop must make its growth and reach full development in the early summer, not only because they must be on the early market, but also because high temperatures injure the vines and check tuber formation. On the other hand, the crop planted in midsummer can develop slowly, in fact the heat of midsummer, without the aid of available nitrogen, promotes a growth that is softer than it should be to withstand the dry spells that invariably occur. For this reason the organic fertilizing materials, like tankage, bone, blood, etc., are the best for the late planted crop. Where the land is rich from continued applications of barnyard manure, acid phosphate at the rate of two to three hundred pounds per acre in the row with the seed pieces may be all that is necessary. If a hardy enduring plant can be built up and carried along until the cooler nights of September, then it will be able to use more food and thus ensure a better crop than a softer grown one that would wilt in the heated soil of the earlier months.

Two favored formulas in the early potato district of the Eastern Shore carry seven per cent of ammonia and five per cent, respectively. The phosphoric acid and potash are the same in both cases, eight and five. These goods are applied at the rate of from five hundred to two thousand pounds per acre. Machines are used that distribute and mix the fertilizers and soil in the rows, and the potato planter drops only the potato seed pieces. The best crops are generally obtained where a rich piece of land has been in pasture for a few years, but fair crops are grown where there has been a good winter cover of rye and vetch.

In the central portions of the state, where the late crop is produced on farms of low fertility, a clover sod is used, or sometimes vetch has been planted after the previous summer crop, this is turned down in May and the land kept mellow until planting time about the last week of June. About three to five hundred pounds of 2-8-5 formula is sown in the row with the seed pieces. The two per cent of ammonia in this case is mainly from tankage.

In the mountains the oats, clover, and potato rotation is followed. The operations are small and there is generally enough barnyard manure to keep the soil fertile so that there is no general use of commercial fertilizers like that of the Eastern Shore.

In conclusion it might be said that notwithstanding the immense amount of experimenting that has been done with fertilizers on potatoes, the end is not yet. There seems to be always new forms of fertilizing materials appearing especially with regard to those carrying nitrogen, so that it is not possible to be very specific when

considering their use. We do know, however, that potatoes require rich soil and the best soil on the farm should be selected upon which to grow them. The potato ground should be given the greatest attention and care with regard to keeping up its fertility. Crops that are known to be exhausting should not be planted on the potato plot. A rotation in which legumes are used would be more likely to keep the land fertile than if corn and wheat or other grains are planted.

When using "rested" land that has been in sod for several years the plowing should be done early enough so that the sod be almost decayed before the planting is done. If a dressing of well rotted manure can be applied to this kind of land it wll be found to improve it immensely. If manure is not to be had a fertilizer containing nitrogen mainly in the organic form will sometimes do better than an all chemical mixture. Fields that have been in sod for some years, or under other forms of "resting" seem to be able to assimilate animal manures and organic fertilizers to a greater extent than land that is continually under the plow. There are probably many reasons for this, but it is sufficient to know that large crops are usually secured from such conditions. This is true not only for potatoes but also for several other of the field vegetable crops.

Finally, it may be said that our soils should be kept fertile and it will pay better in the end, to be as liberal as circumstances permit with the use of fertilizers on the land. In looking back over many years of experimenting with all kinds of fertilizing materials, it cannot be recalled that there was any case where fertilizing properly has not given profitable increases. Medium applications of seven-fifty to one thousand pounds of complete commercial fertilizer per acre have usually given more increase, per pound applied, than larger amounts, especially when used on rested land.

THINGS WE DON'T KNOW ABOUT FERTILIZATION

H. G. Zuckerman, Zuckerman Bros., Stockton, Calif.

This article is a sketchy resume' of five years intensive application of commercial fertilizer, applied yearly to approximately 2000 acres of peat land, situated in the delta of San Joaquin River, adjacent to Stockton, California.

There are a great many more things that we don't know about feeding a plant and soil action than we do know so this article will necessarily have to deal with a recitation of the things that we don't know rather than talk about the things that we think we know.

In actual field practice about the only thing that we definitely know at the present time is that commercial fertilizer helps materially to increase yields of potatoes and onions. We think we know

from actual field practice that in our particular peat soil that potassium and phosphorus are necessary and that nitrogen is not necessary. We also think we know that it is necessary to apply potash and phosphorous in almost equal quantities.

Each year we have been constantly increasing the amount of fertilizer applied to each acre and we have not yet reached, in our estimation, a limit to which it is profitable to apply fertilizer. In the season 1925, we materially increased application of fertilizer over the previous year, using in 1925 one-half ton of 10-20 mixture per acre. With this application of fertilizer our 1600 acres of potatoes produced an average yield of 175 sacks of potatoes per acre, each sack approximating two bushels, therefore, giving an average of approximately 350 bushels of potatoes per acre. In this production we raised a number of fields of potatoes of consequential acreage that ran as high as 800 bushels of potatoes per acre of No. 1 potatoes, of very high quality as indicated by the premium obtained. The interesting point here is that when the yields were largest, the quality, shape and size were the best and potatoes commanded a premium of 50c in the market. We also had fields which ran considerably less and this brought our average on the entire acreage down to 350 bushels per acre. However, in each instance where the yields were light, we believe the reason was due to factors other than fertilizer and we are continually working toward the elimination of these detrimental factors.

In the season of 1926 we are going to apply 1000 pounds of 23-24 mixture which will give us practically equal quantity of potash and phosphorus and practically double the amount of phosphorus we used the year before. The chemicals are being applied in the simple state, being drilled into the soil with separate lime spreaders, both being propelled by the same tractor. After broadcasting, the fertilizer is immediately turned into the ground with discs and this application is made in the fall and early winter and the ground is then left alone until early spring.

This is about all we actually know about fertilizer. We have attempted to find out some real facts in field practice by maintaining control plots and making field tests by using various proportions of fertilizer but the results are very erratic and it looks in a great many instances as if they almost lie. Tests made in the field only give one set of results a year and these results are so bound up with factors that exist and over which we have no control and which cannot be measured that the results from these control areas are of very dubious value so before we can know really accurately how much fertilizer we should put in a given field, what form it should be put on in, when it should be applied relative to the growing plant, as well as consideration of the rain moisture, we must develop some method of laboratory procedure which will make possible accurate tests of what the potato plant really needs in the way of food and secondly what is happening in the ground to supply this food. The first problem, that is, determining what

food a given plant needs, is not so difficult. The University of California has recently done some very good work in the study of wheat and barley grown in pure solutions and have arrived at with reasonable accuracy, just what these growing plants need and when it is needed. The same thing will have to be done with the potato plant and it will have to be determined in what chemical form the food is necessary and at what time of the development of the plant that a certain food is necessary and for how long it is necessary. When this is determined for the potato plant it will simplify several of the seemingly inaccuracies that exist at the present time.

The study of the chemistry of the soil is more difficult because of the complexities of the various elements that go to make up chemical composition of the soil. All past practice which considered the soil as being in a static state will have to be discarded and an entirely new chemistry adopted and before this chemistry can be considered as adequate to the solution of the problems, it must be of such a type that it will take into consideration that the soil is in a continual state of change or is dynamic. There are hundreds of factors that go to bring about this continual change in the soil such as sunshine, rain moistures, wind with resulting evaporation, changes in the soil solutions due to bacterial action and the absence of all these factors and their presence or absence in varying quantities, all of which happen from hour to hour and day to day.

Therefore, until science develops for us some method of measuring the soil in the laboratory so that we can know what food is available for the plant and how much food the plant needs at certain times, we cannot have hope to apply fertilizer accurately or economically.

The University of California is doing some work along this new chemistry and it is hopeful to state that probably it will not be many years before a new science of soil chemistry and technology will be available to replace the old technology which talked of humus and even went so far as to discuss humic acid. We are never going to get to the fine points of the application of fertilizer so that we can make each dollar's worth of fertilizer produce its quota or return until these problems are worked out in the laboratory and when the laboratory methods are finally established and the general principle laid down, then we can prove by the laboratory measure what is happening in the field and what man can do to change the soil condition to produce the optimum condition for the growing plant. After general principles, linking the laboratory with field practice, are established, then the individual field will have to receive its individual study and see what tale it tells. So projecting our minds into the future, we believe that the large farmers in the future will have to have their chemists with adequate equipment just as the manufacturing plant or steel foundry or any

other individual organization has to have its chemical control in order to operate economically.

We hope by trial and error methods to eventually raise our average production per acre of potatoes to 600 or 800 bushels per acre but we are also sure that we are never going to reach maximum economy in our production until we secure some assistance from the laboratory. We also know likewise, that the average production in the United States is never going to be increased very much until the country as a whole is given the benefit of improvements in cultural methods and fertilizer applications which are the results of truths discovered in the laboratory. When these truths are once uncovered, the linking up with field practice is going to be comparatively simple in principle though possibly somewhat complex in application and this is going to entail numerous chemists who will have to work in conjunction with the fields all over the United States. This condition presents a wonderful opportunity to our Agricultural Schools because we are going to need thousands and thousands of chemists who are trained in the new soil chemistry in order to properly run a farm and I believe that what I have said herein is applicable to everything that grows and that the farmer of the future will be told what to do and what not to do, when to do it and how to do it by the chemist. In the meantime, the fertilizer companies, although they are doing the best they can, are practically of no assistance to anyone because they know nothing about what the soil needs, when it needs it and in what form it needs it, or how much it needs at a given time and any representations that are made by anyone at the present time should be taken with a great deal of skepticism.

HOW SHALL FERTILIZER BE APPLIED?

Ove F. Jensen, Assistant Director, Northern Division, Soil Improvement Committee, National Fertilizer Association

Fertilizer when improperly applied is frequently observed to have a "burning" effect, resulting in poor germination, poor stand, and a stunted early growth. Sometimes the poor stand or stunted growth is overshadowed by a vigorous growth later, and the net effect of the fertilizer may be favorable. It is evident, however, that the greatest effectiveness of fertilizer is not being realized under such conditions. In a certain test in a middle western state where 1000 pounds of fertilizer was applied on twelve plots in twelve different ways, the difference in yield between the best and the poorest methods of application was 100 bushels per acre. Without doubt this difference of efficiency in the use of fertilizer is represented many times in the field practices of many potato growers.

There are several reasons why method of application has become of greater importance in recent years than formerly. First, there is a tendency to use larger amounts per acre. Secondly, there is a decided trend in the direction of more concentrated fertilizers. New chemical discoveries are rapidly bringing forth more concentrated fertilizer materials. The higher the concentration of plant food in a fertilizer, the greater must be the care in applying. Indeed, there is a limit in concentration beyond which it is not desirable to go with present fertilizer distributing machinery.

A third factor which has made the method of application of greater importance is the use of new materials or carriers by the fertilizer manufacturer. The high grade fertilizers of today are quite different from those of ten or fifteen years ago, especially in the nitrogen or ammonia they contain. Mr. James M. Bartlett, Chief Chemist of the Maine Experiment Station, states that in 1910, most high grade fertilizers carried less than one-third of their nitrogen in mineral form, such as nitrate of soda or sulfate of ammonia, and two-thirds or more in organic form, derived from such materials as tankage, dried blood, meat meal, etc. Recent analyses, Mr. Bartlett goes on to say, show that conditions are now reversed, and that the fertilizer which does not contain two-thirds or three-fourths of its nitrogen in mineral form is the exception rather than the rule. Animal tankage at one time formed an important source of nitrogen in mixed fertilizers, but at present ninety per cent of all tankage goes into animal feeds.

In all probability the use of mineral nitrogen in fertilizers will increase, rather than diminish, since the cost of the organic carriers, such as tankage, blood, fish meal etc., is getting so high as to be prohibitive for use in fertilizers. When fertilizers were made up largely of organic ammoniates, method of application was of small importance. With the more soluble mineral fertilizers, method of application is extremely important. Potato sprouts are very sensitive to fertilizer salts. If fertilizer is applied too close to the seed pieces, the young sprouts are unable to obtain water for growth because the fertilizer salts absorb water so eargerly. Row application seems preferable to broadcast, because of its greater effectiveness. With broadcast application, serious losses of nitrogen through leaching are likely to occur in a wet season. It has been pretty well established that fertilizer salts do not move horizontally in the soil to any great extent. Highly soluble fertilizers placed above the seed pieces, even though separated from the seed by soil, are likely to cause some retardation in germination in a wet season. Likewise, fertilizer placed under the seed is likely to have a similar effect in dry seasons, when capillary water from below rises to the surface, carrying with it the soluble salts of the fertilizer. Theoretically, then, the best place for fertilizer would seem to be at the sides of the seed, somewhat mixed with the soil. This, indeed, is the location used by several of the most progressive

types of potato planters with fertilizer attachments. In one planter type, for instance, two discs open up a double furrow, into which fertilizer is applied through double distributor tubes. Immediately following the fertilizer application, a seond furrow opener splits the ridge between the two furrows, and deposits the seed at the bottom of the furrow, at the same time covering and mixing the fertilizer in the furrows at either side of the seed furrow. Direct contact of the seed with the fertilizer is impossible with this type of planter.

In another type of potato planter with fertilizer attachment, a shoe following the fertilizer distributor mixes the fertilizer with the soil before the seed piece is dropped. If the mixing shoe breaks, the farmer usually regards it as rather unimportant, with the result that the seed is planted in direct contact with fertilizer with consequent disastrous results.

In those sections where large fertilizer applications are made, it is common practice to apply with a one or two row distributor, followed by the potato planter with planter in the furrow made by the distributor. No especial difficulties are encountered in this method of application.

How shall fertilizer be applied? The evidence of various fertilizer experiments points strongly to the superiority of row application over broadcast. In a test conducted on Long Island from 1905 to 1908, fertilizer was broadcast and drilled on alternate plots, and successive pairs of plots received 500, 1000, and 1500 pounds of 5-8-5 fertilizer per acre. On eight fields, the average difference in favor of drilled in the row was 7.3 bushels per acre.

In three tests in New Jersey, using 1950 pounds of 4-10-4 fertilizer per acre, application at the sides of the seed, slightly below the seed gave the greatest increase of five methods tried. This location also gave the best results in a test at Mason City, Iowa, which included 12 different methods of application. Two years work at Spooner, Wisconsin, has given varying results, from which no conclusions as to method of application can be drawn.

Applying fertilizer in direct contact with the seed may have been a safe practice years ago, but with the change in fertilizer materials, it is a distinctly dangerous practice today. There are still fertilizer attachments made today which do not properly apply fertilizer. Unfortunately, when poor results are secured, the fertilizer gets the blame. There is a need for a greater appreciation on the part of both potato grower and implement manufacturer of the importance of proper fertilizer application.

For applying amounts up to 1500 pounds per acre, the fertilizer attachment on a planter which mixes the fertilizer with the soil in the row, or applies the fertilizer in bands at either side of the seed pieces, is safe and satisfactory. Large amounts are probably more advantageously applied in a separate operation with a row distributor, followed by the planter. In the light of existing in-

formation, it seems likely that either of these methods will give results superior to broadcasting,—that is, they will result in the greatest efficiency in the use of fertilizer, with consequent greater returns, in which, after all, the grower is most interested.

GROWING AND FERTILIZING POTATOES ON MUCK SOILS

P. N. Davis, President of Hollandale Cooperative Marketing Association, Hollandale, Minnesota

There has been much discussion throughout the country as to the fitness of muck soils for potato production and the quality of the tubers raised on this kind of soil. It is possible to raise a small crop of poor potatoes on the best of muck soils, but if the proper methods are used the quality of the product and the yield cannot be approached by many mineral soil potato sections.

Poor drainage is the cause for many of the failures. If the water table can be maintained at from 3½ to 4 feet, we have the first essential for a large quality crop. If the water table is less, the crop may be small and misshapen.

The second factor is good preparation of the seed bed. All trash should be plowed under from 8 to 10 inches and if the soil is new, the fibrous material must be rolled and disced until it is in good tilth. In many sections they call the soil peat until it is broken down into small particles and turned from brown to black. It is then called muck. Rolling after planting always produces a better crop.

On account of the extra large size of the vines and the tendency of the tubers to set further from the hill than in other soils, it is generally practical to plant the rows from 38 to 40 inches apart. This extra width is necessary in spraying when the vines have reached their maximum growth. The hills in the row are planted from 7 to 8 inches apart. As high as thirty bushels of seed can be used if the seed pieces are very large. The Irish Cobbler, being a heavy feeder, seems to give the best yields year in and year out. Bliss Triumph also does well on this class of soil and would be a good proposition if mosaic could be abolished. The Russet Burbank makes a fine quality potato on this soil although it yields a little less than the Cobbler.

The most important factor in raising a good crop on muck soils is the proper application of the right amount of fertilizer. We have tried out nitrates, acid phosphate and potash, singly and in various combinations for three years on the Hollandale tract, and after checking all results carefully have reached the following conclusions:

1. The fertilizer should be applied in the row as deep as possible, spread out 8 to 10 inches and so as not to come in contact with

the seed. 600 pounds of 0-9½-27½ applied in the row with planter gave as good results as 2000 pounds applied broadcast and disced in before planting.

2. In no case or in any combination with other fertilizers did nitrates give any increased yields, and in some cases decreased the yield.

3. Barnyard manure proved very unsatisfactory because in every case it produced scab which remains in the soil for quite a few years following the application. Also 20 tons of manure applied per acre did not produce as large a crop as $12 worth of commercial 0-9½-27½ mineral fertilizer.

4. Check fields with no fertilizer gave an average of 110 bushels of U. S. No. 1 Irish Cobblers per acre.

5. Three hundred pounds of 20 per cent acid phosphate alone gave an average of 170 bushels of U. S. No. 1 Irish Cobblers per acre. Any increase of phosphate did not increase the yield, any less decreased the yield.

6. Three hundred pounds of 58 per cent California Muirate of potash alone increased the yield 208 bushels of U. S. No. 1 Irish Cobblers per acre. Any increase did not increase the yield, any less decreased the yield.

7. Six hundred pounds of 0-9½-27½ gave an average yield of 431 bushels of U. S. No. 1 Irish Cobblers per acre. Any less decreased the yield and any more did not increase the yield.

8. When other mixtures were tried the yield was not as satisfactory. Increasing the per cent of either phosphate or potash did not give larger yields and any decrease in the per cent of either gave smaller yields.

9. We have found that where 1000 pounds of 0-9½-27½ was applied broadcast on onion ground for two successive years and the ground was then put into potatoes that 400 pounds of 0-9½-27½ applied in the rows was as effective as 600 pounds.

10. It was noticed that early frosts had little or no effect on potato vines that were fertilized with 600 pounds of 0-9½-27½, while the vines with no fertilizer were frozen half down by the first light frost.

11. Although a muck soil is primarily composed of nitrogen and organic matter, we have found that a green crop plowed under every few years aids the bacterial action and gives better results with what fertilizer we use.

12. Potatoes raised on muck soil without proper fertilization may be somewhat watery and the flavor may be somewhat off, but with proper drainage and fertilization the flavor and texture cannot be improved upon. In fact Hollandale potatoes raised exclusively on muck soil have brought a premium of 25c per cwt. for table stock on all markets over other potatoes the last three years.

13. People who have used Certified Irish Cobblers and Certified Bliss Triumphs from our muck soils the last three years report

that this seed germinates earlier, matures from ten days to two weeks sooner, and in most cases the yield of U. S. No. 1 potatoes has been greater than potatoes from mineral soils.

14. The yield of potatoes on muck soils properly drained and fertilized is very encouraging. The average yield of U. S. No. 1 Irish Cobblers this year at Hollandale on muck three feet deep or deeper among thirty or forty of the best growers was well over 400 bushels to the acre. A few farmers harvested over 500 bushels of U. S. No. 1 potatoes to the acre.

Summary: Muck soils in various states or in different parts of the same state may vary in the amount of natural phosphate or potash which they contain. These results, of course, are applicable only to the Hollandale tract and muck soils which have similar analysis. We believe that muck soils are ideal for potato growing if properly managed. The one limiting factor seems to be when the location is too far north and early or late frosts are prevalent. Also when the location is too far south, the average temperature may be too high for a large crop.

POTATO CULTURE AND FERTILITY PRACTICES IN THE RED RIVER VALLEY

T. M. McCall, Horticulturist

Potato production practices in the Red River Valley of Minnesota are becoming more standardized each year. In the early years of potato production in the Valley, the potato was the chief cultivated crop and was grown not only as a cash crop but also as a land cleaning crop. In more recent years other crops such as corn, sugar beets, sweet clover, red clover and alfalfa have come in and removed much of the responsibility of weed eradication from the potato crop.

When the Red River Valley first achieved fame as a seed production center there were no standard fertilization practices for the building up or maintaining the fertility of the soil. The impression was current that the supply of plant food in the soil was sufficient for many decades, hence many growers felt that with our low acre cost of production that competition with other potato producing sections could be successfully met. Periods of low prices and diminishing yields have exploded the theory that profitable production can go on forever without adding back to the soil, some at least, of the plant food elements removed.

Potato Problems Studied

Progressive potato growers have been striving to learn the best production practices for their land and through the work of the Experiment Stations and the cooperative work done with farmers, definite, tangible production practices have been evolved. The Northwest Experiment Station at Crookston, Minnesota has long

appreciated this problem and in 1910 started definite projects in potato production.

Theoretically, the fertility problem would seem to be the greatest problem in a region where continuous grain cropping was prevalent but the writer soon found through the fertilizer and rotation experiments that the getting of the clay loam soils back into good physical condition was the most important problem.

The soils which had become compact through misuse had to be loosened up by proper cultural practices and the addition of humus forming materials. It was found at the Northwest Station that two tons of straw per acre were as beneficial as a normal application of any of the commercial fertilizing materials.

Clover Is Needed

Rotation experiments at the Northwest Station demonstrated also that clover in the rotation on the heavy soils was more beneficial than a standard application of acid phosphate. The white sweet clover has proved to be a "miracle" or "wonder working" crop for the Red River Valley in loosening and opening up the heavy soils for potatoes and other crops.

Sweet clover is coming into prominence as a green manuring crop, especially on farms where the supply of barnyard manure is limited. The 1925 results at the Northwest Station demonstrate the value of sweet clover as a preparation crop for the potato. Sweet clover land was handled in four different ways, namely: (1) A seed crop was taken; (2) a rank first crop was plowed under; (3) medium growth second crop was plowed under and (4) a second crop was mowed and plowed under. Land on which barley had been grown was fall plowed and used for comparison.

Results in Sweet Clover Utilization Project

The sweet clover plots in which a medium second growth was plowed under ranked first in yield, producing 200.8 bushels per acre. The seed crop land was second with 188.2 bu. The rank first crop of sweet clover which was plowed down produced 158.6 bushels which was the poorest of the four plots but was some better than the barley land which yielded 148 bushels.

It is the writer's observation from work conducted thus far that the greatest benefit comes to the soil when the sweet clover has made a good root development and when only a medium growth of top is plowed down as green manure.

If the second crop is plowed under before much seed forms a maximum decay can be expected and ample opportunity will be afforded for one or two fall cultivations. Potatoes on sweet clover land withstood the mid-summer floods of 1925 much better than on ordinary stubble land.

It is evident that green manuring crops alone are not sufficient for the maintenance of the soil fertility and that food elements removed from the soil by the crops should be replaced in some manner. Both barnyard manure and commercial fertilizing ma-

terials are being used in the Red River Valley and efforts are being made to determine the kind and amount of each to apply to the potato crop.

How Much Manure to Apply

The Northwest Minnesota Experiment Station has, in cooperation with the Division of Soils, Department of Agriculture, University Farm, St. Paul, been conducting a rate-of-manuring test. The rates of application of the manure vary from 4 tons to 32 tons per acre. The manure, with one exception, is applied once during the four year rotation.

It has been found that the amount of rainfall during the growing period has a great influence on the effectiveness of both manures and chemical fertilizing materials. During dry years the smaller manurial applications have produced the greatest returns and in wet seasons the medium and medium heavy applications yield best. On the average, however, for a seven year period the four tons of manure per acre have produced the greatest number of bushels of potatoes per ton of manure applied.

The following increased yields were obtained per ton of manure applied: 4 tons, 4.18 bu.; 8 tons, 3.72 bu.; 16 tons (eight tons every two years), 3.21 bu.; 16 tons (at one time), 1.89 bu.; 32 tons, 1.14 bu. These results demonstrate quite clearly that excessive amounts of manure, in regions with medium amounts of rainfall, cannot be applied with profit.

Fertilizers for Potatoes

Eleven years' work with fertilizing materials alone and in combination have shown that increased yields can be obtained on potatoes, but that in normal years of medium or low prices the added yields hardly offset the added cost of production. Potash fertilizers when applied alone have not shown any effect on yields. Nitrogenous fertilizing materials vary in their response from year to year but on the average their effect on potato yields on rotated land have been negligible.

Acid phosphate has been the cheapest of the commercial fertilizing materials and has given fair to good results on potatoes. Acid phosphate when used at the rate of 360 lbs. of 16 per cent per acre has on the average in a four-year rotation produced an average increase of 28 bushels of potatoes per acre, when applied broadcast. During the past five-year period phosphate applied in the row has produced an average increase of but 12 bushels per acre.

Complete fertilizers have produced slightly higher yields of potatoes than acid phosphate but the increased yields have cost more per bushel than the increases from phosphate. Both phosphate and complete fertilizers were profitable during the past season when the grower received high prices for his potatoes but with prices in the production centers of from $.40 to $.50 per cwt. the cheaper methods of soil fertilization should be practiced unless the soil is deficient in some one element.

Growers that have used 500 and 600 pounds of phosphate per acre have not profited by the heavy applications on the heavy soils.

Recommended Potato Growing Practices

Observations throughout the heavy soil area of the Red River Valley and data collection from experimental projects leads the writer to the following conclusions in regard to desirable potato production practices. A logical four-year rotation is most desirable.

A four-ton application of manure, once in the rotation, is most desirable.

A judicious use should be made of the commercial fertilizing materials, especially those such as phosphate which show beneficial residual effects on other crops such as the legumes that follow the potato in the rotation.

FIELD STUDIES WITH NEW NITROGEN SALTS

B. E. Brown, Biochemist, Bureau of Plant Industry, U. S. Department of Agriculture

Nitrate of soda and sulphate of ammonia are our chief inorganic nitrogen salts. Of the former, we imported from Chile last year fairly close to 1,000,000 tons—a huge order. As is well known, sulphate of ammonia, which is obtained as a by-product of the coke and coal-gas industries, yargely the former, is our chief domestic source of inorganic nitrogen. In 1924 about 550,000 tons of sulphate of ammonia were produced in the United States, of which the greatest consumption was for fertilizer purposes.

The remaining familiar class of fertilizer materials, the organic, is represented by such materials as dried blood, tankage, fish scrap, cottonseed meal, calcium cyanamid, etc. As far as practicable the trend is away from the use of organic nitrogen materials represented by the first four, due largely to economic reasons and to their profitable use in animal feeds. It is the latter competition that tends to a greater demand for the organic materials with a consequent higher price per unit of nitrogen. A comparison of the cost of unit values of nitrogen in both classes of materials, inorganic and organic, shows a much higher value is placed upon organic nitrogen.

It has been and is yet considered desirable to use some organic nitrogen in the manufacture of well proportioned fertilizers. Recently, however, there appears to be a tendency to utilize more fully the inorganic salts, keeping the quantity of organic at a minimum, in order to cut fertilizer costs. If this can be done without sacrifice of good keeping quality, mechanical condition or yields it will be no doubt a desirable economic step.

A more recent class of fertilizer materials, salts of high concentration with respect to the plant food constituents, nitrogen, potash

and phosphoric acid, is greatly in evidence and is receiving considerable attention. In this class we find salts like ammonium phosphate, (14 per cent ammonia and 60 per cent phosphoric acid); ammonium nitrate, (42 per cent ammonia); ammonium chloride, (31 per cent ammonia); urea, (56 per cent ammonia); potassium phosphate, (52 per cent phosphoric acid and 34 per cent potash); potassium nitrate, (16 per cent ammonia and 44 per cent potash) and others of equally high concentration.

That the greater use of chemical salts in the manufacture of fertilizers possesses a marked trend is evidenced by the much greater production of air-derived nitrogen salts, especially in Europe.

It is estimated at present that at least one-half of the world's inorganic nitrogen comes from the atmosphere through nitrogen-fixation methods, as against only 7 to 8 per cent in 1913. The production of such salts means as a rule concentrated salts, or salts possessing a high nitrogen content.

A number of the salts have been suggested for fertilizer purposes but on account of certain physical properties or scarcity no serious commercial consideration has been given to them by the fertilizer industry until lately. On account of competitive influences brought to bear by offerings of foreign-produced salts a greater interest is being taken in such materials.

The Office of Soil Fertility Investigations early recognized the importance of testing under field conditions some of these newer salts, including ammonium nitrate, ammonium chloride, ammonium phosphate, calcium nitrate, urea, urea phosphate, potassium phosphate, potassium nitrate, etc.

While recent work considers the use of some of the above materials in concentrated fertilizer mixtures, only here will be considered their employment in ordinary fertilizer mixtures.

The cooperative field work was conducted on prominent soil types[1] in Maine, New York, (Long Island), and Virginia.

In order to compare the effectiveness of the different nitrogen salts each salt was used in a complete fertilizer mixture as the sole source of ammonia. In Maine and New York a 4-8-8 mixture was selected as the fertilizer formula; in Virginia, a 6-8-6. Nitrate of soda and sulphate of ammonia were used as comparison salts.

In Table 1 are given potato yields for 1923, 1924 and 1925 in Maine and Virginia; for 1924 and 1925 on Long Island.

It is evident from an examination of Table 1 that the various salts tested have given comparatively good results. In Maine, on Caribou loam, the average yields obtained with any of the new nitrogen salts were ahead of the nitrate of soda or sulphate of ammonia mixtures.

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1. **Caribou loam, in Maine; Sassafras loam, on Long Island; Sassafras sandy loam, in Virginia.**

TABLE I

Results Secured with New Nitrogen Materials on Potatoes. Variety Grown--Irish Cobbler. Potato Yields Stated in Bushels Per Acre.

Nitrogen Salt used in Fertilizer Mixtures	HIGGINS FIELD Mapleton, Maine Caribou loam. Formula, 4-8-8				FOX FIELD, Southold, (L. I.), New York, Sassafras loam. Formula, 4-8-8			SCOTT FIELD Bridgetown, Va., Sassafras sandy loam. Formula, 6-8-6			
	Season of				Season of			Season of			
	1923	1924	1925	Average	1924	1925	Average	1923[3]	1924	1925	Average
	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
Nitrate of Soda	328.5	346.5	257.0	310.6	266.0	235.0	255.5	105.9	156.0	187.9	149.9
Sulphate of ammonia	317.5	339.0	283.0	313.1	287.0	223.5	255.75	133.5	187.0	216.3	178.9
Ammonium nitrate	338.5	359.0	334.0	343.8	321.0	231.0	276.0	137.9	142.0	228.2	169.4
Ammonium chloride[1]	348.5	334.5	333.0	335.3	290.0	236.0	263.0	122.8	153.0	183.3	153.0
Ammonium chloride[2]	342.5	299.0	344.0	328.5	292.0	215.0	253.5	144.2	168.0	183.3	165.2
Ammonium phosphate	344.0	349.0	336.0	342.6	299.0	211.0	255.0	141.9	203.0	210.8	185.2
Urea	344.0	348.5	352.0	348.1	339.0	194.0	266.5	152.2	147.0	222.8	174.0
Urea phosphate	324.5	378.0	330.0	344.1	325.0	219.5	272.25	129.1	178.0	208.0	171.7
No fertilizer	210.9	204.3	211.3	208.8	221.3	183.3	202.3	63.2	149.0	125.1	112.4

On Long Island, on Sassafras loam, the new materials showed up well, although not generally as effective as was found in Maine.

In Virginia, on Sassafras sandy loam, the chief item of comparison centers around the generally better showing of the ammonium salts, or those which would through bacterial action, like urea and urea phosphate, first give rise to ammonia.

In the present work the use of individual salts as the source of ammonia in the mixtures does not imply that such is necessarily advocated as a practice, but is done in order to obtain proper experimental comparisons.

It is felt that these less used salts as shown by the present work are worthwhile from a fertilizer and crop production standpoint. That some of them, like ammonium nitrate, may have undesirable physical features in bulk mixtures or in storage will mean that a study of different methods of preparation, mixing, storage and application may have to be worked out just as had to be done with some of our more ordinary salts and their mixtures.

The ammonium chloride salt was used in two mixtures. In one mixture sulphate of potash was used as the source of potash; in the other, muriate was used. These mixtures were tested in order to throw some light on the effect of extra chloride on the growth and yield of the potato. In Maine the advantage was in favor of the ammonium chloride—sulphate of potash mixture; the same was true on Long Island; but in Virginia the ammonium chloride—muriate of potash mixture was better.

In conclusion, the results on three distinct soil types in widely separated sections show that these newer salts, in comparison with mixtures made up from two of our ordinary nitrogen salts, have done well. Their introduction into routine fertilizer practice will no doubt be gradual, as it should be, in order to allow sufficient time to study in a practical way their behavior on other crops and soil types, as well as how their mixtures behave in bulk and the best method of applying them in the field. The latter is of particular importance if concentrated mixtures made from such salts are being tried out.

POTASH IN RELATION TO POTATO PRODUCTION ON A NUMBER OF SOIL TYPES[1]

B. E. Brown, Biochemist
Bureau of Plant Industry, U. S. Department of Agriculture

For a number of years the Office of Soil Fertility Investigations has been interested in fertilizer work on various crops. This work has been carried on largely under field conditions and major consideration has been paid to the soil type; more especially to conduct the field experiments on soil types of a representative character as

1. A part of general studies relating to the effect of potash salts on potato yield, quality and composition.

to area and importance. The work has included, (1) studies to determine suitable proportions of nitrogen, phosphoric acid, and potash for different crops on prominent soil types, (2) comparative studies with different nitrogen carriers and varying percentages of nitrogen in fertilizer mixtures, (3) field tests to determine the comparative effectiveness of potash salts and different percentages of potash in the mixture, (4) varying rates of application and (5) varying percentages of phosphoric acid in the mixture.

The crops included in the field work are as follows: Potato, sweet potato, cotton, sugar-beets, sugar-cane, corn, wheat, celery, lettuce, tomato, and certain other special crops.

In the present paper consideration will be given to some field work covering the effect of varying percentages of potash on potato yields in comparison with a fertilizer mixture containing nitrogen and phosphoric acid, but no potash. The field work as reported herein was carried on in Maine,[1] New York,[1] (L. I.), New Jersey, Pennsylvania, and Virginia,[2] during 1923, 1924 and 1925.

In the accompanying table (Table I) are given potato yields secured in five locations with fertilizer mixtures containing varying percentages of potash (K_2O).

1. In cooperation with the Maine, New York, New Jersey and Pennsylvania Agr. Exp. Stations.
2. In cooperation with the Virginia Truck Experiment Station.

TABLE I. Showing Potato Yields Secured on Different Soil Types with Fertilizer Mixtures Containing Varying Percentages of Potash, as Compared with No-potash Mixtures.

YIELDS EXPRESSED IN BUSHELS PER ACRE

Percentage of Potash Used in Mixture	MAINE[1]—Caribou loam				NEW YORK[1]—Sassafras loam				NEW JERSEY[1]—Sassafras loam				PENNSYLVANIA[1]—Berks shale loam				VIRGINIA[2]—Sassafras sandy loam			
	Season of			Average	Season of			Average	Season of			Average	Season of			Average	Season of			Average
	1923	1924	1925		1923	1924	1925		1923	1924	1925		1923	1924	1925		1923	1924	1925	
%	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
0	288.5	304.0	297.0	296.5	258.3	266.0	161.0	228.4	80.0	203.5	88.5	124.0	230.0	306.0	285.5	273.8	108.5	223.0	179.0	170.2
3	325.0	350.0	309.0	328.0	270.7	283.0	166.0	239.9	90.0	211.0	83.0	128.0	307.0	316.0	339.0	319.7	121.1	265.0	210.8	198.9
5	342.0	341.0	336.0	339.6	260.6	287.0	190.0	245.9	99.0	224.0	88.5	137.2	320.0	327.0	348.0	331.7	143.4	244.0	221.8	203.1
7	348.0	337.0	308.0	331.0	258.6	272.0	213.0	247.9	99.0	231.0	93.5	141.2	341.0	328.0	353.0	340.6	142.4	228.0	236.5	202.3
9	334.0	352.0	332.0	339.3	255.3	273.0	185.0	237.8	100.0	230.0	85.0	138.3	345.0	331.0	351.0	342.3	138.8	216.0	192.5	182.4
No Fertilizer	210.9	237.5	211.3	219.9	118.6	221.3	183.3	174.4	56.8	72.9	72.2	67.3	213.5	292.0	266.0	257.1	63.2	149.0	125.1	112.4

[1] 4-8-0 used as No-potash mixture.

[2] 6-8-0 used as No-potash mixture.

In the first column of the table under the heading, "Percentage of Potash Used in Mixture," the O refers to the mixture containing only nitrogen and phosphoric acid; the 3, 5, 7, and 9 to the percentages of potash added to the nitrogen-phosphoric acid mixture. This would mean, for example, that in Maine, New York, New Jersey, and Pennsylvania, a 4-8-0 mixture was compared with a 4-8-3, 4-8-5, 4-8-7 and 4-8-9. In Virginia, due to a higher nitrogen requirement, a 6-8-0 mixture was compared with a 6-8-3, 6-8-5, 6-8-7 and 6-8-9. For the sake of further comparison the yields secured without fertilizer are given opposite, "No Fertilizer."

The table contains the items necessary for making comparisons. The yields are for the years 1923, 1924 and 1925, with averages of same for any given location. Certain seasons like that of 1923 and 1925, especially in New Jersey, were not conducive to high yields, while 1924 was a very favorable season. Nevertheless, comparisons are in order regardless of seasonal conditions. As indicated, these results were obtained as a part of a general study and only brief comment will be made at this time.

In Maine on Caribou loam, taking the average results, there will be noted a good response from the use of potash, most marked with the 5 per cent mixture. The average increase was 43.1 bushels for this particular mixture. That the beneficial effect of the nitrogen-phosphoric acid control, or no potash mixture, was considerable is evident when the marked increase in yield over the no fertilizer control is noted, an increase of 76.6 bushels. By adding potash a further increase of 43.1 bushels was secured.

On Long Island, New York, with Sassafras loam, potash is again effective, but less so than for Maine. The no-potash, or 0 mixture, provided an average yield of 228.4 bushels. The 3 per cent potash mixture increased this to 239.9; the 5 per cent mixture to 245.9; the 7 per cent mixture to 247.9; whereas, the 9 per cent mixture took the down grade. Whether the 6 bushel increase obtained with 5 per cent of potash over 3 per cent of potash would make profitable the use of the two additional units of potash will depend upon the price of potatoes. It would certainly have been justifiable in 1925.

In New Jersey, on Sassafras loam, the results are also somewhat in line with the Sassafras loam on Long Island and indicate the advantage of potash in the mixture, possibly slightly more so than is indicated for Long Island.

In Pennsylvania, on Berks shale loam, the best response from potash was obtained. This, too, in the face of a soil type which contains more total potash than any of the other soils. It is of interest to note that the average yield of the no fertilizer was 257.1 bushels, which was increased only 16.7 bushels or to 273.8 bushels by the application of the nitrogen-phosphoric acid mixture (4-8-0). When 3 per cent of potash was added the average yield was increased to 319.7 bushels, an increase of 45.9 over the 4-8-0 mixture. By adding 5 per cent of potash an average yield of 331.7

bushels will be noted. This is an increase of 57.9 bushels. With 7 per cent the increase was 66.8 and, finally, 68.5 bushels with 9 per cent of potash, indicating probably that over 7 per cent is unnecessary on this soil type.

In Virginia, a large increase was obtained over the unfertilized by the nitrogen-phosphoric acid mixture (6-8-0), a gain of 57.8 bushels. At the same time, the addition of potash up to a certain point was quite helpful, a gain of 28.7 being secured with 3 per cent, 32.9 bushels with 5 per cent.

By averaging the results for all potash mixtures (3, 5, 7, and 9 per cent) there is found for Maine, 334.5; for New York, 242.9; for New Jersey, 136.2; for Pennsylvania, 333.6; and for Virginia, 196.8 bushels; then, by getting the difference in yield between the foregoing and the unfertilized as well as between the nitrogen-phosphoric acid mixture and the unfertilized, the part played by potash in the increased yields can be calculated.

Location	Average Yield of Potash Mixtures	Yield of Unfertil'zd	Diff.	Yield of no Potash Mixture	First Column —4th Difference	5th Col'm. ÷3rd
	Bushels	Bushels	Bushels	Bushels	Bushels	%
Maine	334.5	219.9	114.6	296.5	38.0	33.2
N. Y.	242.9	174.4	68.5	228.4	14.5	21.2
N. J.	136.2	67.3	68.9	124.0	12.2	17.7
Penna.	333.6	257.1	76.5	273.8	59.8	78.2
Va.	196.8	112.4	84.4	170.2	26.6	31.5

The last column gives the percentage ratio of the increase in yield ascribable to potash for the soil types studied. The increase due to potash on the basis of the present results is as follows: For Maine 33.2; for New York, 31.2; for New Jersey, 17.7; for Pennsylvania, 78.2; and, finally, for Virginia, 31.5. That is, out of every 100 bushels increase due to the complete fertilizer the above percentage values may be translated into bushels to show the part of the increase due to potash.

In conclusion, it is fairly evident that the effect of potash on the yield was considerable with some variation being shown, however, among soil types.

POTATO SHIPMENTS RELATIVELY HEAVY

(Contribution from the Fruit and Vegetable Division, Bureau of Agricultural Economics, U. S. Department of Agriculture)

"Fewer potatoes but heavier fall shipments," may sound contradictory, but such is the fact this season, as in previous years of

light production. Whenever the deficient-producing late-potato States have a crop which is below normal, they are compelled to draw more heavily from the great surplus-producing States. The net result is more active shipments, in spite of the lighter general supply of potatoes. The present season opened unusually early in the North and carlot movement to mid-December had exceeded 90,000 cars from the leading late-potato sections. To the same time last year, only 83,000 cars had been forwarded. Production in 1921 was almost as short as the 1925 crop, and the middle of December that year saw 97,000 cars shipped from the leading States, just as from the relatively light crop of 1923 about 94,000 cars were moved to December 15. These heavy early shipments, of course, mean proportionately lighter supplies remaining in country storage for future requirements. From the growers' and shippers' standpoint, therefore, the market outlook after January 1 indicates plenty of room for the remaining stocks of potatoes.

The following table presents an interesting comparison between the production in important potato-shipping States and the carlot movement during the first half of the marketing season:

Production and Shipments of Late Potatoes in Surplus-Producing States

Season	Production (bushels)	Shipments, second week of December (cars)	Shipments to December 12, current year (cars)	Shipments to same date in previous year (cars)	Total shipments for previous season (cars)
1925-26..	238,154,000	2,378*	89,487*	82,973	183,928
1924-25..	308,556,000	3,400	82,973	94,043	193,426
1923-24..	287,564,000	2,848	94,043	87,622	186,034
1922-23..	325,479,000	2,355	87,622	97,500	185,369
1921-22..	263,052,000	2,462	97,500	73,510	140,696

*Subject to change.

Recent carlot movement has been lighter than the early December shipments of any of the last few years. Only in 1920 were forwardings considerably less, totaling 1,900 cars, as against the output of about 2,400 cars during the week ending December 12, 1925. At this time last season, 3,400 cars per week were rolling to market, but that was an exceptional volume. Most of the important States have shipped larger quantities than to mid-December, 1924, the excess movement ranging from 2,700 cars in Wisconsin to 300 cars in Oregon and Nevada. All the western States together show an excess of 6,000 cars to date, indicating heavy movement from the West to supply the eastern deficiency. Pennsylvania and Long Island together are running 3,000 cars ahead of last season's early movement, and Maine about 1,000 cars ahead. Greatest decreases, compared with 1924, are 3,500 cars in Minnesota, 2,400 cars in western New York, 700 in South Dakota, and 450 in central California, leaving a net gain of 6,500 cars for the 18 leading late-potato States.

Trading continued limited in the important shipping sections, but the northern Maine and western New York f. o. b. markets closed firm on December 12. Country dealers east of the Mississippi were then getting $3.25-$3.65 per 100 pounds for best stock, while growers in the western sections received $2.70-$3. A slight advance occurred at west Michigan points and in southern Idaho. Sacked New York Round Whites closed 25c above the previous week's level in the Rochester section, with a 40c advance reported on bulk Green Mountains in Aroostook County, Maine. Cold weather was experienced throughout the North; temperatures in Maine dropped to 8° below zero. Although city prices were irregular, there was a firm undertone, and Chicago carlot sales of sacked Northern Round Whites closed considerably higher at $3.50-$3.65 per 100 pounds. Boston, Pittsburgh, Cincinnati and St. Louis reported trading rather slow and market dull. Bulk New York Round Whites were lower in New York City at $3,45-$3.60, and Long Island Green Mountains were bringing exactly a dollar more than western New York stock, with Maine Green Mountains ruling $3.85-$4. Pennsylvania Round Whites were selling around $4. Texas carlot markets quoted western potatoes mostly at $3.75-$3.85.

First arrivals of new stock from Texas were bringing $7 sacked per 100 pounds in St. Louis; these were field-run Bliss Triumphs. Future potato prices will depend not only on the seasonal changes in shipments but also on the extent of previous damage by freezing and decay. Reports show that in many sections, especially in Idaho, Colorado, the Great Lakes region, and New York, there is much shrinkage when the potatoes are sorted for shipment and sometimes further shrinkage at city markets. This, of course, applies mostly to stock that was not dug and stored before the freeze.

Canada has already sent about 1,200 cars of potatoes to the United States, compared with 200 all of last season, but the available surplus in Canada seems to be rapidly decreasing. The November wholesale price in British Columbia was $55-$65 per ton, and local dealers predict that the retail price may equal $100 per ton before spring. It is expected that some supplies may have to be imported from the United States. The duty on such imports is $35c per 100 pounds. In the Kingston district of Ontario, growers were inclined to hold for higher prices, most of them refusing to sell at $2 per bag of 90 pounds. The Kingston market recently quoted this stock at $2.50 per bag, and many dealers look for an advance within the next few months.

(Author's note: Because the December crop estimate,—the final report for the year,—was postponed until December 22, this review could not include the latest production figures.)

POTATO NOTES INCLUDING CERTIFICATION

Colorado—The Fifth Annual meeting of the Pacific Northwest Potato Growers' Association was held in Spokane, Washington, November 17th to the 20th. The general conferences were held in the Hall of the Doges of Davenport Hotel.

The potato show was held in the Chamber of Commerce rooms. Mr. C. Tice read a very interesting paper on seed potatoes and the certification work. Mr. Tice stated that considerable progress was being made for the education of the Chinese potato growers in the use of certified seed. This was done by furnishing certified seed to some of the Oriental growers and their plots served as demonstrational plots and the neighbors have been quick to realize the value of better seed.

Mr. A. E. McClymonds, Supt. Aberdeen Station of Idaho, was on the program to talk on dry land seed, but devoted his time to discussion of strains of potatoes. He stated most of the certified

potatoes had been grown in these test plots. The writer discussed irrigated seed, bringing out the fact that irrigated seed was being used successfully by growers in the Greeley District and a number of letters were read from growers who had planted the irrigated seed sold by the station. The effect of altitude, latitude, effect of soil and irrigation were briefly discussed.

Mr. J. A. Grant, Commissioner of Markets of British Columbia, read a very interesting paper on marketing. Mr. Grant has given much thought to marketing problems.

Potato diseases were discussed by H. E. Morris, of Montana, J. M. Reeder and C. W. Hungerford of Idaho and B. F. Dana of Washington. Mr. Morris devoted considerable time to mosaic and kindred diseases, while the Idaho speakers discussed seed treatment. The Idaho Pathologist recommended pre-sprinkling before treatment. They also expressed themselves as being in favor of the hot formaldehyde treatment, although they reported successful results with the pre-sprinkling treatment followed by corosive sublimate.

Mr. Heath, Horticulturist of Invermere Station, read an interesting paper on preparation of seed potatoes, including potato storage, greening and other seed potato problems. Mr. Heath recommended the cutting of potatoes and letting the cut surface heal over before planting. There was considerable discussion of this point among those present. Many of the southern Idaho potato growers contended that they had received much better results by applying air slack lime to the cut surface. It afforder much discussion and it is believed that the use of lime by the southern Idaho potato growers had acted as a repellent to insects which had destroyed much of the untreated seed.

Mr. R. C. McCroskey, a potato grower of Garfield, Washington, gave a very interesting discussion of potato growing of that section. Much of his time was devoted to cultural methods to preserve moisture. Mr. McCroskey is a very successful farmer and potato grower and his talk was very instructive.

Mr. C. W. Cater, a potato grower of Burley, Idaho, and Mr. O. C. Stansell, of Ashton, Idaho, also gave interesting talks on growing seed potatoes and storage.

There were about 250 exhibits of seed potatoes at the potato show. There were many entries of Russet Burbanks, Triumphs and Idaho Rurals and the quality of the exhibits was very good.—**W. C. Edmundson. December 3.**

SEED CERTIFICATE IN BRITISH COLUMBIA

One of the most important factors in seed certification is early roguing. The detrimental results caused by leaving plants affected with virus diseases such as mosaic in the field until bloom time have proven that early roguing is essential. For this reason the

certifying agency have discontinued the practice of notifying growers when the first inspection is to be made. Where growers were notified it was found that there was a tendency on their part to delay roguing until just before the inspection was made. It is impossible to make all the inspections at an early date. It is essential, however, that the roguing be done as soon as disease appears if the purchaser of certified seed is to receive disease free tubers.

Some sections are growing more varieties for certification than are recommended by the Department of Agriculture. However, growers are beginning to realize the advantages obtained by a district specializing in one or two standard varieties. This is especially true where associations are attempting to establish an export trade.

On account of the extreme dry weather the season of 1925 was not conducive to high yields of potatoes.

In addition to adverse growing conditions many commercial fields suffered severely from virus diseases due to planting inferior seed. Mosaic was the worst of the virus diseases with which growers had to contend and certain varieties such as Green Mountain, Early Rose and Sir Walter Raleigh seemed to suffer more than usual although no variety was absolutely immune. In some commercial fields the percentage of plants affected ran as high as 70% with an estimated loss in yield of 40%. Rhizoctonia also caused considerable loss during the season. It is difficult to estimate the amount of damage done by this disease. However, in the majority of cases where the corrosive sublimate treatment was practised the loss was considerably reduced. Damage by wire worm in some sections is serious. It was present in small proportion in most potato sections in the Province and in a few exceptional cases as high as 75% of the tubers were injured by this pest. The problem of control is a difficult one as up till the present there have been no easy control measures devised that have been found effective and economical. In some instances growers have controlled this pest with partial success by proper systems of crop rotation and tillage but the necessity of investigational work in regard to further control measures is very apparent.

The acreage planted to commercial potatoes for the season 1925 in British Columbia amounts to 19,463 acres. The yield is estimated at 5.24 tons per acre. The acres grown for certified seed amounts to 477 acres with an average yield of eight tons per acre. Observations made over a period of several years show that certified seed gives a much higher yield than ordinary stock. The value of planting certified seed was further shown by the results of potato field competitions held during the season by various farmers organizations. In every case where awards were given for the best commercial fields such awards were taken by fields produced from certified seed.—**S. S. Phillips, Field Inspector. November 12.**

CERTIFIED POTATOES IN MANITOBA

Bin inspection of potatoes eligible for certification has been practically completed in Manitoba. The weather conditions were exceedingly bad for digging during the first part of October. As a result of this many acres of commercial stock was frozen in the ground, although practically all the fields on certified stock were dug with very little frost injury.

Prices for table stock were very good this fall, and a few of the growers sold a large quantity of their potatoes, that were eligible for certification, this way. Buyers from North Dakota and Minnesota bought up all the white varieties they could get hold of and shipped them south. It is interesting to note that a year ago Winnipeg market, which is the largest market on the Canadian prairies, was flooded with potatoes from the above mentioned States.

No certified seed has been shipped this fall, although a few growers have contracted for spring delivery. There will be approximately 10,000 bushels of certified seed for sale in the province this year. However, it is possible that a portion of this amount will be sold as table stock, as the prices are rapidly rising and it is probable there will be a great shortage of potatoes in Manitoba this winter.—**J. W. Scannell, November 5.**

Michigan—Weather conditions in Michigan have been very unfavorable this fall for the successful digging of the potato crop. Frequent rains and snows during October prevented field work and as a consequence it was estimated that by the last of October approximately 30% of the potato crop was still in the ground. During the early part of November there have been several clear days and no doubt most of the crop is out of the ground by this time. It is impossible at this time to state accurately the percentage of injury caused by field frost. Fortunately in the northern portion of the state there was a sufficient fall of snow to prevent serious frosting of the potatoes. It is estimated that the percentage of loss caused by freezing in the field is 10% of the total crop of 26,300,000 bushels. The quality of the Michigan crop this year is estimated to be 90%.

The certified seed acreage listed for inspection this year was 2,145 and the number of acres certified was 1,876. While the acreage entered for inspection this year was somewhat lighter than last year, the number of acres certified this year is 65 acres more than it was last year. The percentage of rejections being approximately one-half of what they were last season. Over most of our certified seed area there were long periods of drought during the summer and the average yield per acre from certified fields will be much lighter than it was last year. The bin inspection of

the seed is not yet completed and the exact figures on the total production are not available at this time. It is estimated, however, that the total production of certified seed in the state will be about 70,000 bushels less than it was last year. Practically all of the certified seed crop was dug prior to freezing weather and the general quality is exceptionally good. The demand for certified seed has been heavier this year than heretofore.

This year there will be a special class of certified seed known as registered seed. This seed will consist of a few of the lots of certified seed that have exceptional merit in the matter of seed selection, freedom from disease, etc. No doubt there will be approximately 5,000 bushels of registered seed available for sale. It is intended that the registered seed be placed in the hands of certified seed growers with the idea of bettering the certified seed crop of the state. I have carried on some experiments on the control of Hollow Heart and I may have some material available for publication at an early date. Further work along this line will be carried out next season, also some plantings will be made in the greenhouses this winter to determine if Hollow Heart can be produced under artificial conditions.—**H. C. Moore. November 21.**

Ohio—This state is one of the few states in the East which had a larger potato crop this year than last. I presume that this is partly due to seasonal conditions, yet the use of good seed had undoubtedly meant a larger yield of potatoes for the past two or three years than was the case five years ago.

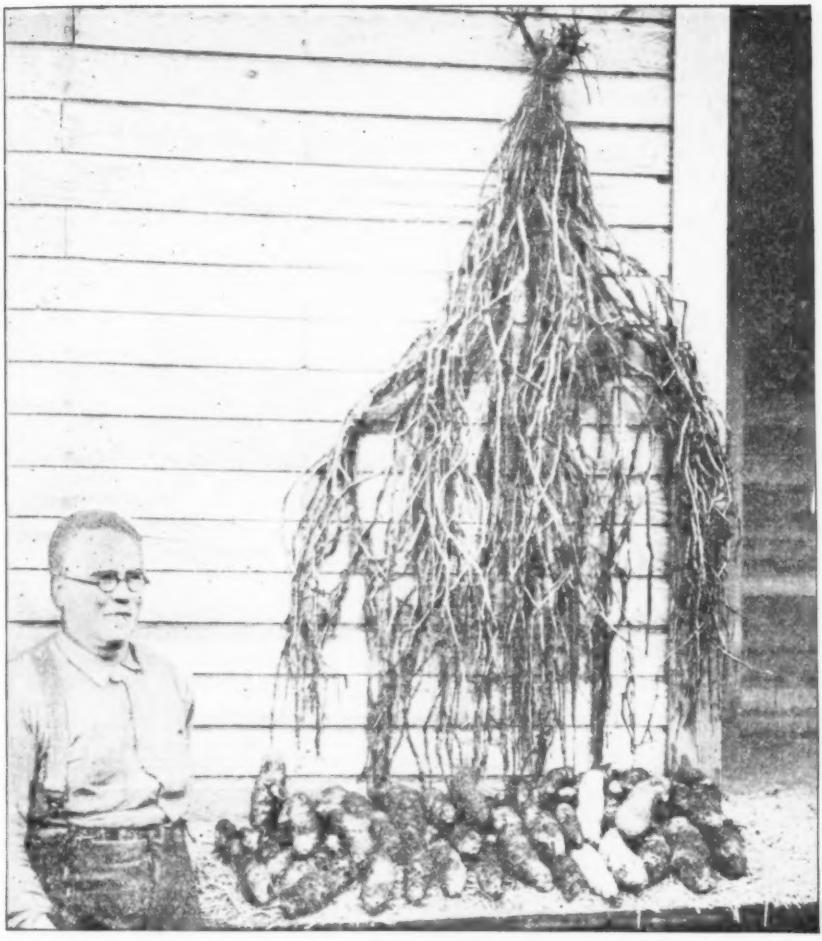
I am enclosing a copy of a statement which appeared in the Farm and Dairy, Salem, Ohio. This gives the yields per acre for Trumbull County in 1924 as compared with 1919. Owing to the heavy rains of the season of 1924 the potato crop was planted late and in many cases on soils which were so wet that they should not have been worked. 1924 was, therefore, not a favorable year for potatoes and the yields were lower than they are this year. I feel that it is safe to attribute the increased yield per acre to the use of better seed.

Never have Ohio potato growers had so much difficulty in harvesting their potatoes as they have had this season. There was almost continuous rain from late in September until the middle of November. The rainfall was not so heavy but it never dried up.

On some of the heavier soils this delayed the harvesting of the crop and as the season advanced many growers resorted to hand digging, paying high wages for hand diggers.

The good price the crop is bringing has helped the proposition, but two weeks ago there were still quite a number of potatoes still in the ground. The wet weather caused some rotting on the lower land.

I will be glad to send you some items from month to month.—**Earl Jones. December 21.**



A LARGE HILL OF POTATOES

The other day the editor received a copy of the above picture and the information given below from George L. Zundel, Extension Specialist in Plant Pathology, State College of Washington, Pullman, Washington.

"Last spring Mr. Adolph Heck of Monroe, Washington planted a whole eight-ounce tuber of the Pride of Multnomah variety. The soil was a sandy loam of such a nature that it would not bake. **Phosphorus, potassium and nitrogen were applied in the form of commercial fertilizer.** The plant was watered to keep it growing

"On October 28, 1925, A. Z. Smith, the County Agent, J. P. Keaton and myself were called to the Heck's ranch. We found that the eight-ounce potato that Mr. Heck had planted had pro-

πr² = 3.1416 × 44 = 133.9 384 = 154 sq. ft
= 1/283 acre.
20 65 9 lbs. = 344 lbs.

duced five stems that had branched so that the vine covered an area of 14 feet in diameter. This hill was dug and was found that it had produced 73 potatoes and that they weighed 73 pounds. The largest tuber weighed 3 pounds."—**Signed, George L. Zundel.**

POTATOES IN TRUMBULL COUNTY

Farm and Dairy

Salem, Ohio, November, 1925.

The farm census figures for Trumbull County show a decrease in potato acreage of from 2,710 acres in 1919 to 2,004 acres in 1924, but the yield dropped only from 179,000 to 162,000 bushels, in other words, the yield per acre in 1919 was 66 bushels per acre, while in 1924 it was 80 bushels per acre, an increase in the yield per acre of 14 bushels. It is safe to say that most of the increased yield has been brought about by the use of better seed throughout the country as a whole and that the introduction of certified seed through the County Farm Bureau has been a big factor in increasing the yield per acre on Trumbull County potato crop.

POTATO PRODUCTION IN OHIO

	1925 (bushels)	1924 (bushels)	10-yr. Average (bushels)
Total production	14,204,000	11,500,000	10,724,000
Average yield per acre....	106.0	92.0	79.0 (9 yrs.)

THE VERMONT POTATO CROP

The Vermont crop of certified and uncertified potatoes was considerably under the average this year.

Depressing prices last season brought about a natural curtailment in acreage. A prolonged dry spell in August, and early September together with some blight injury, all combined to bring about a small crop. In addition considerable loss resulted from frost injury both in and out of the ground during October. The worst digging conditions imaginable were encountered in harvesting of 90% of the crop.

Available Potatoes.

First, Table Stock—Report is prevalent among housewives, storekeepers, and dealers that the farmers are holding their potatoes, that their bins are full, and that next spring there will be plenty of potatoes. Careful and comprehensive work of the writer substantiated by reports of others who have actually studied the situation prove that this is not true. On the contrary many farmers will have to buy potatoes for home consumption and for planting. Potatoes will have to be shipped in from outside to supply the demand in Vermont.

Second, Seed Potatoes—About one hundred carloads of certified and seed stock potatoes have been shipped from Vermont

to Virginia, New Jersey, New York, and Connecticut. There are remaining unsold aside from the Dimock Orchard Corporation not over five to ten carloads of Certified Seed. The Dimock Orchard Corporation of Bradford, Vermont, in their modern, government bonded, and licensed warehouses at Bradford and Bellows Falls, Vermont, have of their own and cooperators stock about forty thousand bushels Certified Mountains unsold. Offices are maintained by the Corporation at Bradford and Bellows Falls, Vermont. **—H. A. Merrill, December 5.**

THE SHIPPING SEASON IN VERMONT

The special jinx which pursues the certified seed potato grower seemed to be out this year to prove conclusively that "if it isn't one darn thing it's another" in the potato game. If it wasn't the drought, hopperburn and aphis injury of the more southern sections, it was excessive rain and sweeping spread of late blight in Vermont; and then, when this dealer of hard luck seemed to be losing the game through lack of rot in the blighted fields, he pulled a trump out of his sleeve and pretty nearly cleaned up what was left on the board with an early October snowstorm and freeze. The astounding rise in price was the only thing which kept the score anywhere near even.

The result of this freeze and the presence of much mud and some injury from hand diggers constituted the unusual features of the shipping season in Vermont for 1925. Late blight rot has been slight—much less in evidence than has been the case some seasons when blight was much less in evidence in the fields. Despite the climatic freakiness of the season, there was no unusual amount of second growth or other abnormality about the tubers, and the percentage of oversize was less than last season taken upon the same basis. The only change in the Vermont rules touching upon shipping inspection is the raising of the maximum size for the long varieties to 14 ounces.

The Department of Agriculture has reports upon the shipment of about 26,000 bushels of certified seed. A few records are not yet in and it is probable that some have been shipped without tags and, hence, without shipping inspection records. Estimating the yield at 250 for Green Mountains and 225 for Cobblers, there should have been in Vermont about 79,500 and 24,325 bushels of these varieties respectively, from certified fields. Ordinarily we could expect from seventy to seventy-five per cent to grade in as certified seed. The freezing injury has cut both ways, however, and while it is impossible to estimate the loss with any degree of accuracy, it undoubtedly runs into thousands of bushels. It is probable, considering the price situation, that very few potatoes have been sold for

spring delivery, but more appear to have been stored than would have been the case had ordinary prices prevailed.

The heavy snowstorm of October 10, with its subsequent spell of winter weather, caught many fields undug, some potatoes dug but unpicked and, as is usual in such cases, it chilled some which had been dug and temporarily stored in barns. All who have had the slightest experience in this kind of trouble know that the loss is by no means all in the spoiled tubers. Much is in the sorting, resorting and sorting over again to get rid of these potatoes which keep showing up their symptoms.

In addition to trouble from freezing most growers experienced great difficulty in digging on account of continued wet weather. After waiting weeks for the ground to get dry enough for the use of mechanical diggers many growers had to use hand labor, and it was partly on account of this delay that so many fields were caught by the cold snaps. Mud adhering to the tubers constituted another difficulty.

Prices seem to have ranged from $1.65 per bushel in the very early part of the season to around $3 per bushel. Probably small lots have been sold at a still higher price.—**Harold L. Bailey, December 5.**

POTATO MEETINGS

THE NEBRASKA POTATO IMPROVEMENT ASSOCIATION CONVENTION

The Annual Convention and Show of the Nebraska Potato Improvement Association was held at Kimball, Nebraska, on November 12 and 13. The most important phase of this convention was one afternoon's discussions of the seed potato industry of the western Great Plains. The States of Montana, Wyoming, South Dakota, Nebraska and Kansas were represented. The out-of-State men participating were Messrs. Starring, Valentine, Zigler, and Stokdyk. There seemed to be general unanimity of agreement among the certification men from these western States, that, in spite of some reverses and discouragements in some recent years, the seed potato certification work must be maintained at a constantly advancing high standard. One of the matters perplexing inspectors in this region is the difficulty of detecting all of the virus diseases in the course of routine inspections, with each succeeding year, the importance of inspecting fields at least two and preferably three times is becoming more and more evident.

C. C. Starring reported that the commercial certified Triumph seed business is getting well started. They have been discouraging the planting of large acreages and have been emphasizing the importance of quality considerations. George Valentine, from

South Dakota, reported that they have had the greatest development in the certifications of Irish Cobbler potatoes. A very large portion of their crop is each year sold to the growers of the Eastern part of Virginia. E. A. Stokdyk reported the very general adoption of seed treatment practices in the Kaw Valley as a result of which, the returns are much more satisfactory than formerly. The Kaw Valley acreage has been increasing quite steadily each year. The Early Ohio has almost been replaced by the Irish Cobbler. It is quite apparent that there is a splendid and increasing market for good Irish Cobbler seed potatoes throughout the western cornbelt States. The Great Plains have barely started to grow this variety for the seed trade. It probably represents the greatest undeveloped opportunity in the potato industry in that region.

Mr. Fred Taylor, of the Burlington railroad, after making a very careful survey, reported that if the marketing end is properly looked after a very much larger quantity of certified Triumph seed potatoes can be placed in the southern States for commercial planting. Furthermore, there is possibly a still more extensive potential market in the form of the home gardens of the south and the potato patches of the small farmers. This market may be more difficult to develop but once developed it will probably be more constant and less fluctuating from year to year.

One of the greatest needs throughout the entire plains regions is that the commercial growers, not raising seed potatoes, learn about the merits of certified seed potatoes sufficiently well to use that grade of seed themselves. In many of these western regions the industry would probably be more profitable if the growers would use seed of better quality.

As a result of tuber index work done at the Nebraska station, H. O. Werner reported that a large percentage of diseased or otherwise undesirable plants have been discovered in what have been reputed to be the best Triumph strains in several of the northern States. Frequently these plants have shown very mild symptoms that would probably not have been observed under the most favorable field conditions. These are among the most productive strains in the United States, but if they could be thoroughly cleaned up by tuber indexing it is not unreasonable to believe that they could be improved at least 20%.

The concensus of opinion among those who have seriously considered the question was, that the time is at hand when growers should place much more stress upon very severe selection and roguing in connection with the seed plot and thereby eliminate the expensive and at best haphazard roguing of large fields.

That there is no dearth of first-class potato growers for the future was demonstrated by the fact that one of the boys,—a member of a potato club, was awarded sweepstakes for the best individual exhibit. The quality of the Triumph potatoes in the show was exceptionally fine.—**H. O. Werner, December 5.**

Michigan—The Michigan district potato show season closed last week with the Thumb of Michigan Show at Mayville. The week previous the Top O' Michigan Potato and Apple Show was staged at Gaylord. The area represented at this show produces the bulk of Michigan's certified seed potato crop. During the last week in October the Western Michigan Potato Show was put on at Greenville, in which district approximately one-fourth of the potato crop of the state is grown.

Nearly $3,000 in premium money was available for these shows and the total number of entries in the shows was well above 500. The general quality of the exhibits was exceptionally good. Over five thousand potato growers attended these district shows and the accompanying meetings and received valuable information that will help them in producing and marketing better potatoes. Educational exhibits were placed at each show by the Michigan State Department of Agriculture and the Michigan State College. Special emphasis was placed in these exhibits on the more general use of certified seed, better grading methods, etc.

These shows will serve as a good forerunner for the Michigan State Potato Show to be held at East Lansing during Farmers' Week, February 1st to 5th. Judging from the large number of entries at the district shows we will have a state show this year that will far surpass any yet held in Michigan.

The Michigan Crop Improvement Association recently held a Harvest Home Festival at the College for its members. Banquets, inspection trips, barn dances, a corn husking bee, and a potato peeling contest were some of the leading features of the festival. Thirty women entered the potato peeling contest. Each woman peeled five pounds of carefully graded potatoes and then five pounds of un-graded stock. The best time made in peeling the graded potatoes was one minute and fifty-five seconds by Mrs. W. R. Kirk of Fairgrove, Michigan. In peeling the ungraded potatoes Mrs. Edward Coler of Fairgrove won first place in two minutes and nine seconds. The peelings from both the ungraded and graded potatoes were weighed and it was found that the percentage of waste in peeling the carefully graded potatoes was 20.8 while in the ungraded lot the percentage of waste was 45. While the percentage of waste in both cases was considerably heavier than it would ordinarily be under most conditions, yet there is sufficient difference to show the advantage of using carefully graded potatoes. **—H. C. Moore, November 21.**

NOTES ON RECENT LITERATURE

KIRK, L. E., AND C. H. GOULDEN.—Some statistical observations on a yield test of potato varieties.—*Sci. Agr., 6 (1925), No. 3, pp. 89-97.*

Extensive variety tests have been carried on for a number of

years by the field husbandry department of the University of Saskatchewan. In 1924, 20 dstinct varieties of potatoes, 17 of which were the product of superior single tuber selections, were each tested in 15 systematically distributed rod rows, every fifth row being a check. Study of the tabulated yields from individual plats showed that the soil was highly variable and that extensive replication was required in order to obtain reliable results. As determined by the check plat method and by the deviation of the mean method, probable error of the experiment was very high and for practical purposes the same in both cases. The data indicated that the deviation of the mean method gives a reliable probable error and is apparently of special value when the number of checks is small.

The value of replication was studied by determining probable errors by the deviation of the mean method for 1 plat and the means of 2, 3, 5, and 7 systematically distributed plats. The reduction in variability was very close to mathematical expectation and suggested that at least 7 systematically distributed rod row plats were necessary for a reliable test. The relation of the correlation between plat yields and the probable error of a difference is discussed briefly. The correlation between nearby plats was found to be high enough to indicate that it should be considered, although ordinarily small correlations may be disregarded. For adjacent plats rxy=0.6707+or—0.0194, 3 apart 0.5967+or—0.0234, 6 apart 0.5042+or—0.0283, and 10 apart 0.4864+or—0.0305.—**H. M. Steece.**

83 play

LOHNIS, M. P.—Ondezock naar het verband tusschen de weer gesteldheid en de aardappelziekte (Phytophthora infestans) en naar de eigenschappen, die de vatbaarheid der knollen voor deze ziekte bepalen. (An investigation on the relation between the weather conditions and the occurrence of potato blight, and on the qualities that determine the degree of susceptibility of the tubers for this disease).—*Scheveningen, 1924. (English summary p. 112-129).*

1. **Correlation between weather and time of outbreak.**—The meteorological factors rainfall—total and frequency, vapor pressure, relative humidity, and temperature, were studied by periods of 3 or 10 days back to 50 days before an outbreak of blight. Arbitrary limits were assigned for the point at which each factor began to operate. Correlations were sought between the time of occurrence of these limits and between the frequensy of their occurrence, and the outbreak of blight; also with the progress of the disease and duration of the epidemic. No definite correlation with any meteorological factor was found; it was concluded that the factor essential for infection, i. e., the duration of presence of water drops on leaves, being a function of relative humidity, insolation and air movement, no correlation with any one meteorological factor is possible.

2. **Time of application of spray for greatest effectiveness.**—Spray applied just prior to an outbreak of blight, or during its

early stages is effective, and one application may remain partially effective for 4 weeks. Spray applied to the soil was not found to influence the amount of tuber rot. Spraying when the disease appears early and spreads quickly was effective, but was of little use when the disease appears late in the season.

3. **Correlation of resistance to rot with variety and with soil type.**—No correlation was found between the degree of susceptibility of tubers and that of foliage. It is a sound generalization that tuber rot is less on sandy soil.

4. **Factors determining resistance of tubers to rot.**—Previous work showed lack of correlation between extension of mycelium in parenchyma of tubers and resistance to blight rot; similarly for number and thickness of cell layers in the periderm. However considerable protective influence is exerted by the cork cambium, and this character is hereditary.

5. **Manner of entering tubers.**—Phytophthora enters the tuber through lenticels, wounds and the eyes. An important difference exists in the structure of the lenticels, and the readiness with which they are penetrated by Phytophthora. This is in part a varietal difference but in general the lenticels of tubers grown in clay soil are incompletely suberized, and are sometimes cracked whereas the lenticels of tubers grown in sandy soil are generally completely suberized. Phytophthora can penetrate only unsuberized layers, thus in clay-grown tubers resistance to blight rot depends on the cork cambium and the extent to which the lenticels are suberized. In sandy soil this correlation of resistance with degree of suberization of the lenticels is lacking. The resistance of the cork cambium did not appear to depend on anatomical differences, the presence of tanin, or the rate of wound cork formation. It is a property however that can be inhibited by narcotics.

6. **Time at which infection occurs.**—Clay soil was found to be infective after 30 days following inoculation with spores of Phytophthora, sandy soils only about half as long. Non-diseased tubers may become infected in wounds from diseased ones as late as 6 days after wounding, being left meanwhile in the open field. When wounded tubers are kept in moist conditions, immature ones become resistant to infection sooner than ripe tubers, but the difference could not be correlated with wound cork formation. Sound tubers without wounds may become infected from diseased tubers in storage, if grown in clay soil and kept moist, but tubers from sandy soil resisted infection whether kept dry or moist in storage.

7. **Conditions of foliage infection.**—The use of cut leaves did not furnish a reliable criterion of foliage susceptibility, and no correlation between the resistance of the foliage of some varieties and the condition of their stomata during the inception of an outbreak existed. However, it is known that Phytophthora can penetrate ordinary epidermal cells.—**F. Weiss.**

PATCH, EDITH M.—Potato aphids.—*Maine Agr. Exp. Sta. Bul. 323, p. 9-36, figs. 2-6. April, 1925. (Issued October, 1925).*

The aphids infesting the potato and other plants of the nightshade family are discussed together partly because of their importance as transmitting agents of potato degeneration diseases. Aphids infesting potato sprouts can transmit disease. The detailed life history is given of the potato aphid, the green peach or spinach aphid, and the buckthorn aphid. Control is suggested by means of the eradication or the treatment of the overwintering host plants, or by treatment of the potato plants. Roguing out diseased plants should include their destruction. A key, list with synonymy, and partial bibliography are given.—**Donald Folsom.**

WILLAMAN, J. J., AND R. M. WEST.—A statistical study of the composition of potato tubers.—*Minn. Univ., Studies Biol. Sci., No. 5 (1924), pp. 211 227, figs. 5.*

Samples of Rural, Green Mountain, Burbank, and Early Ohio potatoes were collected from various parts of Minnesota, information as to the character of the soil, time of planting and of harvesting, spraying, yield, and abnormalities of the weather being obtained at the same time. The composition of the samples was studied statistically as to variety, soil, locality, and time of maturity.

The composition of American potato tubers did not appear to be influenced by varietal difference is that between the early and the late maturing varieties, the early types being low in dry matter, and high in ether extract, minerals, and nitrogenous substances. The effect of soil could be detected only in a general way in the data. It appears that of the three soils, loam induces the highest dry matter, nitrogen, and ether extract contents, sand the lowest dry matter, and clay the lowest nitrogen. The tubers from the more southern localities in Minnesota are considerably higher in nitrogen than those from northern Minnesota. Both temperature and humidity seem important in this regard.

Analyses of six varieties of potatoes at five growth stages showed that during tuber growth dry matter steadily increased up to the time the vines begin to die. The ratios among the various constituents remain rather constant throughout the growth period. Large and small tubers of like maturity have the same composition.

Strong positive correlation was observed between specific gravity and dry matter, but no correlation of significance between specific gravity and either nitrogen or carbohydrate, when the latter were calculated to the dry basis. The nitrogen is correlated negatively with carbohydrate and with ash and positively with ether extract. The ash bears a negative relation to all organic constituents.

The available facts concerning the composition and properties of potato tubers appears to warrant the conclusion that it should be possible to breed a variety with a higher proportion of protein to carbohydrate, and still with desirable culinary properties. Such tubers would have a higher percentage of dry matter, and they would be spheroidal rather than long or flat in shape.—**H. M. Steece.**

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